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A HISTORY OF TAHITI

BY DR. ALFRED GOLDSBOROUGH MAYER

CARNEGIE INSTITUTION OF WASHINGTON

LYING far to the southward of the paths of trade and exploration, Tahiti remained unknown until in 1767 Wallis saw its splendid peaks in the course of his voyage around the world in the English frigate *Dolphin*. It is true that Pedro Fernandez de Quiros, a Portuguese captain in the service of Spain, was credited with having discovered Tahiti on February 10, 1606, but the narrative of his voyage convinces one that the low-lying atoll upon which he landed, vainly seeking water, was probably Anaa, or possibly some other island of the Paumotos, for, like his predecessors, he sought the full favors of the tropic breeze and was borne to the northward of the most beautiful island groups of the Pacific.[1]

Even to-day, sad as she lies while her native race is dying, Tahiti epitomizes the charm of Polynesia. The missionary Ellis gives us a vivid picture of his impressions as in 1817 he gazed for the first time

upon the varied picturesque and beautiful scenery of this most enchanting island.[2] We had beheld successively as we sailed along its shore, all the diversity of hill and valley, broken or stupendous mountains and rocky precipices, clothed with every variety of verdure, from the moss of the jutting promontories on the shore, to the deep and rich foliage of the breadfruit tree, the Oriental luxuriance of the tropical pandanus, or the waving plumes of the lofty and graceful cocoanut grove. The scene was enlivened by the waterfall on the mountain's side, the cataract which chafed along its rocky bed in the recesses of the ravine, or the stream that slowly wound its way through the fertile and cultivated valleys, the whole surrounded by the white-crested waters of the Pacific, rolling their

1 See "The Voyages of Pedro Fernandez de Quiros," 1595 to 1606, translated and edited by Sir Clements Markham, Hakluyt Society Publications, London, 1904.

2 See, "The Voyages of Pedro Fernandez de Quiros" 1595 to 1606, translated and edited by Sir Clements Markham, London, 1904. Hakluyt Society Publications.

SUNSET OVER EIMEO SEEN FROM THE SHORE OF TAHITI.

waves of foam in splendid majesty upon the coral reefs, or dashing in spray against its broken shore.

And in speaking of the Tahitian valleys, Ellis says:

> There is the wildness of romance about the deep and lonely glens, around which the mountains rise like the steep sides of a natural amphitheater, till the clouds seem supported by them—this arrests the attention of the beholder, and for a time suspends his faculties in mute astonishment, and in the unbroken stillness that pervades the whole we might easily have induced the delusion that we were upon the enchanted ground of nature's fairy land.

Even simple sailor-like Wallis says of Tahiti:

> The country has the most delightful and romantic appearance that can be imagined: towards the sea it is level, and is covered with fruit trees of various kinds, particularly the cocoanut. Among these are the houses of the inhabitants, consisting only of a roof, and at a distance having greatly the appearance of a long barn. The country within, at about the distance of three miles, rises into lofty hills, that are crowned with wood, and terminate in peaks from which large rivers are precipitated into the sea. We saw no shoals but found the island skirted by a reef of (coral) rocks through which there are several openings into deep water.

Tahiti is situated in South Latitude 17° 40′ and West Longitude 149° 25′. In other words, upon the opposite side of the world from the middle of Africa, and nearly at the center of the Pacific Ocean. In outline, it is figure-8 shaped, being a twin island, consisting of two oval land masses joined by the low, narrow isthmus of Taravao. The major axis of the island extends from northwest to southeast, and is only about 37 miles long. The larger land mass, called Great Tahiti, or Tahiti-uni, has about four times the area of Little Tahiti (Tahiti-iti) which lies to the southeastward. The total length of the coast line is not more than 120 miles, and the area of the whole island is only about one third that of the State of Rhode Island.

The peculiar figure-8 shape of the island is probably due to the activity of two originally separate volcanic cones each one of which rose above the sea until their sides touched. But, if this be true, it occurred long ago measured in terms of the life-time of volcanoes for there are now neither hot springs nor other evidences of internal heat upon the island.

Indeed much of nature's sculpturing of valley-wall and peak is due to the great variety of plutonic and volcanic rocks and nepheline syenite upon Tahiti, the differing degrees of hardness of which permitted erosion to carve deeply in some places, while at the same time leaving others to stand in bold relief.

Also the grandeur of Tahitian scenery is due to the fact that its volcanoes were of an explosive type and tore deep fissures into the earth's crust, permitting molten basalt to well upward and cement the rents. Then, when the volcanic fires died down, the rains consummated their

Morea Island Seen from Tahiti after a Storm.

work of washing away the softer rocks, leaving imposing pinnacles of hard basalt such as the sheer precipice Maiao, "The Diadem," at the head of Fautaua valley which lifts its unconquered crest thousands of feet above the soft corroding lavas of the lowlands.

In other places the valleys are spanned by dykes of basalt forming precipices over which the mountain torrents dash in a multitude of graceful cataracts.

The seductive charm of Tahiti is all its own for everywhere the beautiful is wedded to the grand. The stern crags are but nestling places for the mosses of the forest, and fascinated by the sylvan setting of the waterfall where rainbows float on mists among the tree ferns; the roar of the cataract is unperceived; and the coral reefs and shaded shores of fair Tahiti, who can forget them—the glorious sparkle of sunbeams playing over flickering ripples in a riot of turquoise, emerald, and blue is the setting of every picture—the background of every memory. Indeed, it is not where the peaks are highest that Tahiti is loveliest for nowhere in the Pacific do the mountains meet the sea in fairer grace of form and color than at Tautira on the eastern coast of Tahiti-iti. The charmed memory of Tahiti lives only to die with the beholder.

In the Hawaiian or the Tongan Islands, cup-shaped craters constantly remind one of the volcanic origin of the land, but the erosion due to ages of tropical showers has all but obliterated these in Tahiti although the broad concavity in the upper region of Papenoo valley may possibly mark the site of the great central crater of Tahiti-uni.

Nestled under the southeastern rim of this crumbling crater lies the gem of Tahiti, the lovely lake Vaihiria, in a setting of wild bananas,

guava, tree-ferns, and clambering pandanus, and shadowed by precipices towering 3,000 feet above the calm secluded waters. From afar the rivulets dash down until torn by the ragged walls they fade mostly into mist and cloud-like descend in silence to the region of the lake. Although only one third of a mile wide, the natives believed this little lake to be bottomless until our plumb line came to rest at a depth of 80 feet. There is, however, no visible outlet although huge eels glide among the water-weeds, and the mystery becomes cleared away when one goes down into Vaihiria valley where at the foot of a wall of broken rocks a cool clear stream rushes impetuously into the sunlight. In fact the little lake has been formed by a land-slide which has dammed the valley the upper part of which it now occupies.

In every feature Tahiti shows the wear of rain and weather, but still the green summit of Orohena towers 7,300 feet above the level of the sea, and 22,000 feet above the floor of the surrounding ocean. Yet the rains have accomplished much, and the almost constant land-slides show they are effecting more in their persistent work of levelling the grand peaks: and now 150 valleys wind downward from the highlands to the sea.

One is never away from the murmur of rippling water, as the mountain streams splash among moss-covered boulders that have rolled from their ancient lodgment in the cañon sides. As Bougainville wrote, these Tahitian valleys are images of Paradise upon earth. The brooks glide through arches formed by the interlacing leaves of wild banana, the "Fei" of Tahiti, while great caladiums flourish in the ever-moistened soil, and the perfume of vanilla pervades the air. Banyans form

EIMEO FROM TAHITI.

Lake Vaihiaria, Tahiti.

intricate tangles of subaerial roots though the maze of which the waters find their way, and a pretty little perch (*Dules malo*) which rises briskly to the fly disports itself within the swirling pools. Then, at last, the brook courses sluggish and spent to deposit the rich soil, the spoil of the mountain slopes, over the broad alluvial plain which fronts the sea.

Here upon the gently sloping shore-plain are the groves of bread fruit, cocoanut palms, taro and Tahitian chestnut which supported so dense a population in old days that Foster who accompanied Captain Cook upon his second voyage estimated their number at 150,000, although he was doubtless deceived by the crowding of the natives to the shore off which his ship lay anchored. Yet, certainly, in 1769 the villages were not isolated one from another as in other parts of Polynesia, but a continuous line of houses clustered along the shore, and the political unit had become the district rather than the town.

But to return to the history of Tahiti, it was on June 18, 1767, that Captain Wallis perceived the summits of its mountains rise above the sea. On the following morning as he approached the shore the tropic haze hid the island from his view, and when the rising sun dissipated the mist he was surprised to find himself surrounded by a fleet of canoes, many of them double, and 60 feet long, their carved bows curving upward high above the sea, and their pandanus-mat sails of lateen pattern. The more daring finally approached his ship, their commanders bearing clusters of banana leaves which they threw upon the deck, and a few of the more courageous natives were then induced to come on board. Pigs and chickens were recognized as familiar animals, but the sight of a goat so overcame them with fear that they leaped overboard and swam to their canoes.

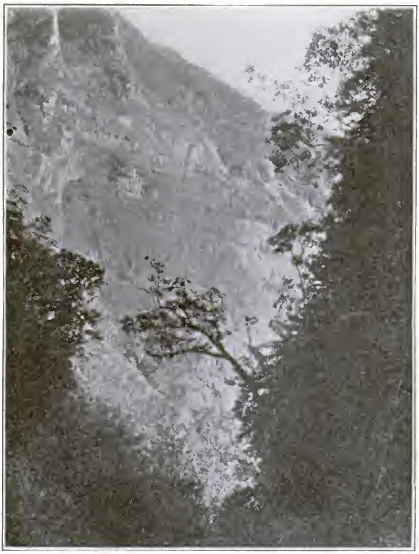
Wallis reassured them through gifts of nails and trinkets, but soon the knowledge of this vast wealth aroused the cupidity of the natives, and for days they attacked his vessel with stones hurled from slings. Finally, on the twenty-fourth of June, about 2,000 natives in 300 large canoes surrounded the ship, and when the high chief threw the crest of a palm tree into the air a general attack commenced. Wallis was forced to use his cannon, but observing that no fire came from his bows, the canoes with white war streamers flying from their sails pressed down upon him fore and aft, only to be shattered by renewed volleys. Yet so persistent were they that on June 26 the *Dolphin* was compelled to shell the shore, sending cannon shot among the houses in the palm groves before the natives broke and fled in terror to the hills. Then after more than 50 canoes in the district had been destroyed a stillness the British described as peace fell upon the scene.

The sullen silence was broken on July 11, when Purea[3] the Chiefess

[3] The "Oberea" of Cook and Banks.

or Ariirahi of the district of Papara came on board and was courteously received by Wallis who presented her with a mirror and a gown, he being under the impression that she was the "Queen" of the Island. As a matter of fact, there was no head chief whose authority was recognized over all parts of Tahiti, and Purea was merely a guest of her kinsman the chief of the district of Matavai Bay in which the *Dolphin* lay at anchor.

Greatly impressed by Purea's commanding presence and with the respect she inspired among the natives, Wallis returned the call on the



A Tahitian Valley.

following day, the natives carrying him upon their backs to the great council house, or Fare-hau of Matavai within which Purea was herself but a guest, although her actions appear to have been those which would better have graced a hostess. The house in which this remarkable reception occurred was 327 feet long by 42 wide and was a shed of palm thatch, the roof being supported upon 92 posts arranged in three rows. The "Queen" and her maidens at once proceeded to massage Wallis and his officers and finally to dress them in native garments, thus reciprocat-

ing his own charity in presenting her with a European gown. The proceedings were, however, marred by the alarming action of the surgeon who suddenly removed his wig, causing the "ladies of the court" to flee in terror from the house.

Purea, having recovered her composure, commanded her followers to present Wallis with great quantities of bread fruit and many pigs and believing her to be supreme over the entire Island he soon persuaded himself that she had ceded her realm to him. Accordingly he hoisted the British flag, saluted it with twenty-one guns, gave each of his men a drink of rum mixed with the water of a Tahitian brook and thus solemnly took possession under the name "King George the Third's Island."

As a matter of fact, Purea was vainly endeavoring to induce Wallis to visit her own district Papara, hoping through the influence of her supernatural guest to augment her own authority, for the natives believed his ship to be a floating island filled with vindictive demons who had control of thunder and lightning; but he understood not a word, and man-like assumed that her "inconsolable weeping" was due to admiration for himself and sorrow over his intended departure. Thus on July 27 did this British Æneas depart from his Polynesian Dido never more to see Tahiti.

Soon after Wallis's departure Louis Antoine de Bougainville independently discovered Tahiti. He was circumnavigating the globe, commanding the French frigate *La Boudeuse,* and the transport *L'Etoile,* and his 200 men were worn with the sea, scurvy threatening. Happy indeed were the French when, on April 2, 1768, from a distance of fifty miles they saw the peak of Orohena, as Wallis had sighted it eight months previously. Favored by the southern trades, they sailed along the shore to anchor on April 6, off Hitiaa; there to remain for a respite of ten days. In his fascinating "Voyage autour du Monde" published in Paris in 1771, Bougainville devoted two chapters to "Taiti," or "La Nouvelle Cythère," as he officially named it, furnishing an impassioned theme for French philosophy.

Bougainville was a keen and sympathetic observer and he made the most of his time from the moment when on April 4 the canoes ventured out to his ships, their chiefs bearing clusters of banana leaves in token of friendship. A hospital was established on shore for the scurvy-ridden sailors, and most friendly intercourse was established between them and the natives, who doubtless profited by their experience with Wallis to refrain from offending the new visitors. Yet, according to Cook, an infliction worse than Wallis's cannon was turned upon the unsuspecting islanders, for the ravages of a virulent infection of syphilis followed closely upon the departure of the French. Corruption and death had entered never to leave the land, and the once gigantic race of

HOUSE OF VAE KAHN, CHIEFTESS OF THE MARQUESAS AT TAE-O-HOE.

old Tahiti was to wither in a lingering decline. Fair as Tahiti was and Paradise as the French regarded it, they were the first to curse it with that infliction which "civilization" has for centuries brought upon the "savage." Sad Tahiti, land of mountain mist, and murmuring stream, of coral reef and tropic palm, and smiling skies was to be henceforth a pest-house for the simple race that knew her for their home.

From a native point of view the situation is well described in the "Memoirs of Ariitaimai" of the great Papara family of Tahiti; who says:.

> For forty generations these people (the Polynesians) had been isolated in this ocean, as though they were in a modern sanatorium, protected from contact with new forms of disease, and living on vegetables and fish. The virulent diseases which had been developed among the struggling masses of Asia and Europe found a rich field for destruction when they were brought to the South Seas.
>
> For this perhaps the foreigners were not wholly responsible, although their civilization certainly was; but for the political misery the foreigner was wholly to blame, and for the social and moral degradation he was the active cause. No doubt the ancient society of Tahiti had plenty of vices, and was a sort of Paris in its refinedness of wickedness; but these had not prevented the islanders from leading as happy lives as had ever been known among men. They were like children in their morality and their thoughtlessness, but they flourished and multiplied. The European came and not only upset all their moral ideas, but also their whole political system.

But to return to our narrative. Captain James Cook, upon the first of his famous voyages visited Tahiti in the man-of-war *Endeavour,*

remaining in Matavai Bay from April until July, 1769. Cook's mission was to observe the transit of Venus, for which purpose as well as for geographical discovery, his expedition had been sent out at the instigation of the Royal Society of London. Accompanying him were such men of science as Banks and Solander whose observations upon the island and its natives at a time when they were as yet unspoiled, have given us the classic account of a primitive Polynesian community, supplemented as it was in 1829 by the scholarly volumes of "Polynesian Researches" written by the great missionary William Ellis.

At the time of Cook's visit, Tahiti was a characteristic Polynesian feudalism, the Ariirahi, or principal chiefs, being dependent for sustenance and political support upon the landed proprietors, the *bue raatira.* But in Tahiti as elsewhere in Polynesia, the supreme chiefs of districts were believed to have descended from God-like heroes of the myths, and their persons were held as sacred, thus greatly strengthening their position in time of political crises.

In acknowledgment of their feudal position, the large landed proprietors or Arii called themselves "the stays of the mast" by "the mast," signifying the Ariirahi, and as elsewhere wherever feudalism has been the social order, the incessant rivalry between nobles had forced the common people to flock to the standards of the few who could best afford protection, and in consequence the Arii, or "baron," of a Tahitian valley might become more powerful in his own domain than was the Ariirahi over the district as a whole. Thus an unstable form of "limited monarchy" was maintained in each district and to secure the suc-

PANDANUS TREE ON THE LAGOON BEACH OF FAKARANA ATOLL, PAUMOTES.

NATIVE OF THE SOCIETY ISLES IN TAHITI.

cession from usurpation, the son of the high chief was granted the family title immediately upon birth, and his father who was the first to do him homage, was nominally at least reduced to the rank of a vassal. Before the missionaries came there was never a "king" whose authority was recognized over all Tahiti, but so great in outward form was the respect paid to the Ariirahi that people who passed their houses or came into their presence removed all clothing to the waist, an act of homage they paid also to the images of gods. The Ariirahi's feet might not touch the ground in any but his native district for all he trod upon became his own. Accordingly, when abroad he was carried upon the back of a retainer, and it was the boast of Pomare that he was greater than King George for he of Tahiti rode upon a man while the king of England was obliged to content himself with a horse.

In their marital relations the Tahitians closely approached the primitive condition wherein all the women are the wives of all the men. The wife of every man was also the wife of his friend, and it is probable that a more licentious race never lived during historic times. As Cook's narrative states, topics which with us are avoided were the chief theme of conversation among the Tahitians.

As elsewhere in Polynesia, rank descended through the mother and for the purpose of maintaining their exalted state, the great chiefs intermarried only among their own kindred, but such alliances were merely temporary, for after the birth of a legitimate heir, women of high rank consorted without scandal with endless paramours, although all their children of uncertain parentage were immediately put to death. In fact, infanticide was established not only as an accepted, but as a lauded institution in Tahiti; and according to Ellis two or three children constituted an unusually large family, and practically every woman had with her own hands murdered some of her own offspring, probably two thirds of the children born in Tahiti being thus disposed of immediately after birth.

In the absence of fatal epidemics and with the ever-present danger of famine through over-population, such barbarous checks upon increase had grown to be considered virtuous, and furnished the tenets of the society of Areoi, said to have been established in remote times by the followers of two celibate gods who although they did not enjoin chastity upon their worshipers prohibited their rearing offspring. Thus these bacchanalians of the Pacific roamed singing and dancing, welcomed everywhere as wits and entertainers; transient spirits flitting through the world each to die the last of his race on earth. They constituted a large proportion of the population, for in Cook's narrative we read of a fleet of 70 canoes filled exclusively with Areoi.

Cannibalism was unknown in Tahiti at the time of its discovery, yet here as elsewhere over the Pacific traces of its having been were there,

A TAHITIAN CARRYING BUNCHES OF WILD PLANTAIN "FEI." The man had come several miles down the mountain side bearing this enormous burden.

for tradition stated that two mythical brothers, the Taheeai, were cannibals but were finally killed through trickery by a Tahitian Hercules, greatly to the joy of all men then living. Also at the time of Cook's visit, the eye of the human sacrifice was placed within the lips of the high chief, and the original name of the late "Queen Pomare" was Aimata, "the eye eater."

As with the Aztecs, these sacrifices appear to have become more numerous immediately succeeding the coming of the white man. Criminals, or slaves who were captives taken in war, were immolated in times of public ceremony as upon the occasion of the inauguration of a new Ariirahi, but the common sacrifices were pigs whose bodies were left to decompose upon the altars as food for the gods who came in the form of carrion birds.

As elsewhere in Polynesia, the worshiped beings were the spirits of

departed ancestors, for to the simple mind all things of nature are of his own kindred, the world was made by a man-like god for man and all things centered round him. Thus the sun was a ghost that plunged beneath the sea at night, the moon was the sun's wife and the stars their children, and every waterfall, mountain peak and valley had its guardian or haunting nymph or good or evil spirit. The ceremonies associated with the worship of the ancestral spirits were usually conducted upon the roof-shaped heaps of stones called the marae which each Arii caused to be erected in his district, each of his retainers contributing two stones to the structure. Cook states that the marae of the high chiefs Amo[4] and Purea in the district of Papara was a prism with an oblong base 267 feet long, 187 feet wide and 44 feet high, having eleven steps or terraces broader at the sides than at the ends. The top was a ridge resembling the roof of a house and at its middle point stood the image of a bird carved in wood while near it lay the broken model of a fish cut in stone. The sight of this stupendous structure, and the statement that each person in the district had contributed two and only two stones may have caused Cook to form his exaggerated estimate of the population of Tahiti. Shapeless and sadly reduced by burning in a lime kiln, the marae of Papara now lies forgotten in the forest by the

MAKING FIRE IN TAHITI, by rubbing two dried sticks of the yellow hibiscus one against the other.

[4] Amo, the "Eamo" of Cook's narrative, was the son of Tuiterai (God of the sky).

FATHER AND DAUGHTER, BORA BORA ISLAND, SOCIETY ISLANDS.

sea. Yet even to-day the ruins of about 40 maraes are still to be found upon Tahiti and Eimeo.

Such, in brief, were the Tahitians, that race of giant men who came to welcome Cook with leafy boughs within their hands—tokens of peace and friendship. And a friendship real as any that can be formed between the weak and the powerful grew up between the great Englishman, whom they called "Toote," and these careless, light-hearted children of the Islands of the Sea. It is of curious interest, however, to observe that intimate as Cook became with his Tahitian friends, he never learned the true name of the Island, his word "Otaheite" meaning "From Tahiti"; Bougainville's "Taiti" especially as the "h" is softly sounded, being far nearer the correct representation of the name.

Without attempting to minimize the barbarity of their customs, let us not permit ourselves to be over harsh in condemning the Tahitians. A primitive race cast far from their original home upon a small island remotely isolated; without iron or metals, or clay for pottery, and living in a warm seductive atmosphere that soothed ambition into somnolency; it is much to their credit that Cook says of them that they were cheerful, generous, cordial, and brave, and Ellis states that theft and crime were of rare occurrence. Such indeed is the consensus of opinion among Europeans who, though not missionaries, lived among Polynesian peoples during the days when they were unspoiled by contact with civilization. In Mariner's fascinating account of Tonga, and Melville's charming story of Typee in the Marquesas we find far more of praise than of condemnation.

Let us remember that practically nothing of invention, art, literature, science or constructive leadership has come from the untold millions of our own race who have been born and bred and spent their languid lives within the torrid heat. Great men such as Hamilton, the first Dumas, or Kipling have, it is true, been born in the West Indies or in India, but their education and achievements were attained in colder lands. The history of the British in India is replete with the tragedy of broken hearts, and every ship bound "homeward" bears its freight of exiled children whose fate it is to become strangers to their duty-loving parents. This uncounted toll of the dull, monotonous, never-ending heat, how different would history have been had our race been born to withstand its merciless suppression.

Just as the first fruits of the renaissance were ripening in Spain, a vision of the Indies came like a mirage from afar to lure onward the ablest of her youth. Into regions unknown they went never to return, and they and their descendants were lost to intellectual Spain. Thus was her best blood wasted and the leaders who might have been were unborn. Spain depleted, drained of her strength, and with too few at home to win the great battle of liberty, withered under the fires of

the inquisition. It was the tropic heat, the infection of the mosquito-haunted swamp, and the demoralizing contact with tropical populations that conquered Spain, not the fleets of the English, for it was years after the tragedy of her great Aramada that Spain's greatest things in art and literature appeared.

Indeed, England herself narrowly escaped the same fate which would have been hers also had she succeeded in supplanting the Spaniard on the mainland of tropical America. Unable to accomplish this, she was perforce obliged to colonize in the neglected north, and the bleak shores that gave her first adventurers so inhospitable a welcome in time became centers of civilization, advancing her culture and her empire over the sea.

Cook returned to Tahiti in 1773 and again for the last time in 1777, and then for eleven years the Island saw no European vessels until October, 1788, when the cry "Ephai! ephai!!" (A ship, a ship!!) echoed along the rocky shores. It was the *Bounty* under Lieutenant William Bligh, R. N., and her mission was to gather young bread-fruit trees in order to introduce this coveted plant into the British West Indies.

Bligh, although a brave and efficient navigator, made himself odious to both his officers and his men, his conduct being that of an irritable, selfish, suspicious tyrant, and much as his men feared him, they hated him even more.

Yet for nearly six months, during which the ship lay moored in Matavai Bay, there was solace for her crew in the wanton pleasures of the tropic isle, and when on the 4th of April, 1789, the anchor rose for the Bounty's last farewell, many a heart was aching under the sailor's blouse and many a dark-eyed maiden watched weeping from the shore.

If Bligh's ugly temper had been trying in the past, it became even more annoying after he left Tahiti. On the 27th of April when off the Tongan Islands, he burst forth into a tirade of abuse, unjustly accusing his officers, and especially his first mate, Mr. Christian, of petty thefts of food.

Throughout the night the *Bounty* lay upon a calm and glassy sea, her sails flapping to the long, low, ceaseless heave of the Pacific, and young Christian, burning under his wrongs, paced hotly on his watch while the ship and all on board lay sleeping.

In the gray of the listless morning before the glaring eastern sun had shown upon the sea, his resolve was taken and the die of Britain's most noted mutiny was cast. Hastening to the forecastle his word was as a spark to gunpowder to the repressed spirits of the crew. Amid deep muttered cursings, the gun chest was torn apart, and Bligh awakened to be led upon deck, his hands tied behind his back. The ship was in dire disorder with mutineer sentinels standing before the cabin doors

of such officers as might have come to their comamnder's aid, but obedient to young Christian's orders, the *Bounty's* launch, a boat only 23 feet long, was lowered, and Bligh and 18 of his men were forced over the side crowding the frail craft until the gunwale was but seven inches above the level of the sea.

But mercy came to temper the fate of those who were to be sent adrift. A hundred and fifty pounds of bread, some water and some wine, a little pork, charts, a sextant, a compass, and a few cutlasses were thrown into the boat. Guns the mutineers refused, and then the commander and his faithful few were cast away.

As if in exultation the *Bounty* awakened to the impulse of the morning breeze and glided off upon the rippling sea while from the throats of her ruffian crew the cry arose "huzza for Otaheiti." As the cheer came over the waters, it brought to Bligh a sense of high resolve to make the best of the narrow chance for life and home that lay before him and his men. But Christian, the mutineer, they say stood moodily with folded arms, his eyes fixed upon the drifting boat which stood for all that remained of law and order on the wave.

A gentleman by birth and training, he might have risen high, an honored servant of his country. Too late the villain cheer revealed to him the dark import of his vengeful act. An outcast he must be forevermore. In a world apart from Europe he must live, and memories of youth and home and friends of other days rose up to curse him as he sailed, archpirate as he was, into a life of wantonness and ruin.

The volcanic peak of Tofoa, one of the Tongan Islands, rose dimly above the northern horizon and toward it Bligh and his men set oars and sail hoping to increase their scanty store of food and water. In this they were foiled for the natives seeing them helpless attacked them with stones, killing one and wounding all so that they considered their ultimate escape fortunate. On and on they sailed for dull days and nights, and always onward until they passed through the uncharted Fiji group and discovered the northern New Hebrides, never daring to land though they suffered all the pangs of starvation. Two meals a day each consisting of $1/25$ of a pound of bread and $1/4$ of a pint of water were all stern Captain Bligh allowed, for his destination was Timor, full 3,600 miles from Tonga. His journal describes their suffering in minute detail, and one must respect the courage and resourcefulness of the leader who cheated death a hundred times in the course of this awful voyage. Through starless nights of storm, bailing constantly, fighting the overwhelming sea, shivering in the rain, blinded by the roasting eastern sun, racked with pain, cramped almost beyond endurance as they crouched sleepless within the boat, they still went on and on and each returning noon saw them nearly 100 miles nearer to Timor.

Occasionally they succeeded in seizing the gulls which flew near the

boat, and each such prize was cut into 18 pieces and devoured. Many sea-snakes were seen but it did not occur to Bligh to use them for food.

One dark and stormy night they heard the roar of breakers close aboard and narrowly escaped being dashed to death upon the Great Barrier Reef of Australia. On the following day, however, they succeeded in sailing through a narrow opening in the reef, elated to find themselves upon smooth waters under the protection of the coral flats. Here they ventured to land upon several small deserted islands where they feasted upon shellfish, replenished their store of water, and above all, enjoyed the luxury of sleep.

Then on they went through Endeavour Strait growing daily weaker upon their reduced ration. Finally, on June 14, 1789, the people of the Dutch village of Coupang on Timor were horrified at the appearance of 18 ragged wretches reduced almost to skeletons who staggered and fell upon the shore while tears of joy streamed down their weather-beaten cheeks.

For 47 days Bligh had sailed across 3,618 miles of almost uncharted ocean, passing dreaded islands of the Fijis and the New Hebrides, surmounting not only the perils of the sea but even greater dangers from murderous cannibals, and his courage as a leader, and skill as a navigator must inspire respect as long as the annals of Britain's navy are cherished as a record of heroism.

But to return to Christian and the *Bounty* whom we left on that fateful morning of the 28th of April, 1789.

Christian knew full well the skill and resource of Bligh and foresaw that should the cast-off commander reach England, Tahiti would be but a death-trap to the *Bounty's* pirate crew. He therefore set his course for the small island of Tubuai, one of the Austral group, about 250 miles south of Tahiti. This lonely spot had been discovered by Captain Cook in 1777, who observed that the natives spoke the Tahitian dialect and appeared to be industrious cultivators of the soil.

Upon the *Bounty's* arrival, they crowded in great numbers to the shore blowing their triton war horns and brandishing clubs. Christian therefore changed his course for Tahiti, where his old friends warmly welcomed the *Bounty* and her crew. Here, however, he remained only long enough to supply his ship with provisions and live-stock, and together with a number of his Tahitian friends he sailed again to Tubuai, this time to be hospitably received.

A criminal in the eyes of civilization, Christian maintained until his death the respect of his lawless crew. They addressed him always as "Mr. Christian" and the generous spirit he displayed in sharing every hardship, no less than his real ability as an executive, showed that had he remained faithful to his country he might have died an admiral of the blue. As it was, he took his part in the immense labor of construct-

ing a fort at Tubuai, digging himself within the moat which encircled the parapet with a depth of 20 feet. But control the innate passions of his ruffian associates, he could not. Their brutal disregard for human rights brought on a war of extermination between the natives and the whites in which Christian himself was severely wounded. Finally, despairing of the impossible task of restoring order, he yielded to the murmurs of his men and returned once more to Tahiti.

Here, late in September, 1789, the *Bounty* anchored for the last time and most of her crew deserted to plunge into the riotous pastimes of the shore, while Christian with eight comrades remained on board. Twenty natives, men and women, joined them, and then early in the morning of September 23, Tahiti awakened to watch the *Bounty* fade from sight beneath the northern horizon.

The expected came to pass, for on March 23, 1791, the British frigate *Pandora* bore down upon Tahiti and those who survived among the mutineers became captives chained to her decks beneath the torrid sun.

But where was Christian and the *Bounty?* For three months the avenging *Pandora* searched in vain, for, like the fate of La Perouse, that of the *Bounty* had become but one more mystery of the Pacific.

Yet there was intelligent method in Christian's leadership. He knew that one day upon Carteret's voyage in 1767 a young midshipman named Pitcairn had seen from the masthead something which appeared to be a barren rock projecting high above the sea, and Captain Carteret had named it "Pitcairn Island." Three weeks Christian spent searching for this isolated land, and at last when almost in despair he found it nearly 180 miles from the longitude assigned by Carteret, but all the safer for a last retreat.

Lost in the vast ocean, far from the paths of man no spot in all the island world was more remote than this tiny islet with its sheer precipices frowning down from eleven hundred feet upon the sea, while back of the volcanic walls concealed from the view of ships, there lay a valley rich in palms and tropic trees. A slight indentation in the bold and unprotected shore marked the last anchorage for the fated *Bounty* ere they sank her far from sight beneath the sea.

Christian divided the island into nine parts assigning one to each of his men and to himself, while the natives became wives and servants to the whites.

And Christian who had fled from all, now fell under the sad shadow of his thoughts. Long hours he brooded sullen and alone within a cave that looked upon the sea and here he read his Bible through and through, yet what availed a mumbled creed to one whose life was blasted such as his! A worthy servant of his king and country, he might have been but for a moment's work conceived in rage. All romance of his wild career

sank down to the dull lusts of savagery's desires. Uncheered he heard his dark-skinned offspring romp and play and sport among the breakers of the shore, their mother's wanton spirit over all. A family worthier of his gentle name he might have reared in England, had he not in the exultation of revenge bartered his birthright to civilization. And lonely Pitcairn lost upon the sea was but a prison for his starving soul where he must languish through a waste of years, his sole alternative oblivion or the hangman's rope.

Feuds bitter, unreasonable and prolonged arose on Pitcairn, and Christian soon was shot, and before ten years had passed midshipmen Edward Young and Alexander Smith were the sole surviving mutineers upon the island. Then a strange change came over Young, who appears to have been a weak, rather than a vicious character. He determined to devote his remaining days to elevating the standards of the entire community. The Bible and Prayer Book that had belonged to Christian were recovered from the cave where they had lain for years neglected, and thus the last of the ill-fated crew turned missionaries and school teachers to the women and children of the colony. In 1800, Young died, his end being unique in that his death was due to natural causes. Thus Smith became sole guardian of this strange community, winning as years passed their love and veneration; for, indeed, he stayed the hand of rage and imparted to the rising generation true principles of civilization.

Nearly twenty years had come and gone and the world had forgotten the *Bounty* in the stirring events of the first decade of the nineteenth century, when one day the American ship *Topaz* under Captain Folger of Nantucket discovered an uncharted island, and a boat manned by brown-skinned English-speaking youths came out to welcome him. Thus was the retreat of the mutineers revealed; Alexander Smith, or "John Adams," as he now called himself being the sole survivor of the *Bounty's* pirate crew; and he lived the revered leader of the islanders until his death in 1829 at the age of sixty-five.

The coming of the *Bounty's* mutineers to Tahiti in 1788 was an event of primary significance in the history of the island. Hitherto Tahiti had been a community of feudalisms, the power of the Ariirahi being constantly checked by the contending claims of rivals; but here as elsewhere over the South Seas, the coming of the white man tended at first to increase the power of the chief they came most in contact with though finally it led to the utter ruin of all native leaders including the "king" himself.

The head chief of the District of Pare in 1789 was Pomare, the nephew of Purea, now grown to manhood. Cook had known him as "Outou,"[5] but upon hearing his little son cough at night he had changed

[5] Otoo's real name was Tunuicaite-atua, signifying descent from the gods.

his own name to Pomare (night cough). He was now in his prime and six feet four inches in height, and armed with a huge club, he was well equipped to inspire terror among his subjects.

Pomare enjoyed the immeasurable advantage of being chief of the region of Papeete (the water basket), for this having the best harbor of the island enabled him to gather enormous fortunes of nails, hatchets, and red feathers from ships, only, however, to be robbed by his rivals upon the departure of his European friends. Thus when the *Bounty* came to Tahiti he was in the direst straits having been forced to "declare dividends" for the benefit of every other Ariirahi of the island. However the sixteen mutineers marooned upon Tahiti found it to their advantage to aid Pomare, and they turned their guns upon his rivals with such cruel slaughter that in a few months he was tyrant not only of Tahiti but of the island of Eimeo. Probably it was fortunate for his schemes that no sooner was his tyranny secured than the avenging *Pandora* came to capture and remove his villainous assistants, who doubtless would in the end have murdered their royal master.

This period wherein one of the high chiefs secured the services of unprincipled white men armed with guns had its parallel in Fiji where it led to the rise of Mbau; in Hawaii it enabled Kamehameha to conquer the entire archipelago; and in Tonga, aided by Europeans, it secured the preeminence of George Tubou.

As in the wars of the roses, the leaders suffered more than the people in these bloody raids for power, and thus the commoners, their local overlords being slain, began to rise in influence, and something akin to public opinion commenced to murmur as a growing check upon the tyrant who now assumed the rôle of autocrat whereas formerly he had been but a moderator. Thus in old times, generosity was considered to be an Ariirahi's highest virtue, and often he gave so lavishly of the tribute he received that in worldly goods he was poorer than many a servant in his train.

(To be continued)

POPULAR MISCONCEPTIONS CONCERNING THE WEATHER

By ANDREW H. PALMER

UNITED STATES WEATHER BUREAU

THE weather is perhaps the most widely discussed of all topics of conversation. It is not unnatural that it should be of such general interest, since every man living upon the surface of the earth is influenced by this feature of his environment. Moreover, atmospheric air is itself one of the elements necessary to sustain human life. So commonplace a subject as the weather, therefore, needs no definition. Ever since man first appeared upon the earth the weather has been an ever-present influence—its changes have affected his actions as well as his very mode of life. It is only during the past century, however, that any real progress has been made in a scientific knowledge of the weather, the influences to which it is subject, and the effects resulting therefrom. Only a beginning has thus far been made in that direction. Meteorology, the science of weather, and climatology, the science of climate, have progressed slowly, and for this reason various misconceptions and superstitions concerning weather and climate have persisted even to the present time. While much is still to be learned about the atmosphere it is already possible to disprove many of these false notions. It is the purpose of this paper to enumerate and briefly to discuss twenty-five of the more common of these misconceptions. No new facts will be presented—the aim simply being to make clear the fallacies underlying these misconceptions in terms of principles generally accepted by meteorologists and climatologists.

The supposed influence of the moon, the planets or the stars is probably the most widespread of all popular misconceptions about the weather. Manifestations of these fallacies are seen in a great variety of ways, including long-range forecasting, the planting and the harvesting of crops, and various events in the husbandry of cattle during periods determined by phases of the moon, etc., all of these being examples of a belief in the relation of heavenly bodies and human affairs. The textbooks in geography still used in many of the common schools frequently combine a brief discussion of astronomy and meteorology in the introductory chapter, thus laying the foundation for considerable confusion in the minds of the children. Moreover, the ancient science of astrology still has a few disciples among the uninformed, as far as the weather is concerned. Meteorologists, however, are now unanimous in the opinion

that the influence of the moon, the planets and the stars (not including the sun) is practically nil, when terrestrial weather is considered. It should be remembered, in this connection, that heat is the fundamental force determining weather—the form of energy outweighing all others combined. When it is stated that the sum total of all the heat energy received from all heavenly bodies (not including the sun) is so slight that one of the most delicate of instruments is required for its measurement, it is apparent that their influence upon our weather is negligible. The moon, about which most misconceptions of this character center, is without doubt the direct cause of ocean and atmospheric tides, and there are places along certain coasts where ocean tides produce periodic tidal breezes. Aside from the indirect effects here enumerated astronomical influence upon weather is practically of no consequence. The untruth of the proverb which states that the moon tends to drive away the clouds is explained partly by the fact that a clearing of the sky at night is not ordinarily observed unless the moon is above the horizon, and partly by the fact that after sunset there is a cessation of the ascending currents which result in the formation of clouds of the cumulus type, the clouds already formed soon dissipating.

Contrary to a fairly general impression, there is no apparent relation between earthquakes and the weather. Scriptural allusions to destruction of life and property often associate earthquakes and violent storms as though they were of common origin, and the idea has persisted, to some extent, even in modern writings. In general, it may be said that earthquakes are caused by forces at work within the earth, or at least beneath its surface, such as the slipping of the crust along a fault plane, or the movement of molten matter or steam beneath the hard crust. On the other hand, weather changes result from the effects of forces at work within the atmosphere itself, primarily as a product of energy coming through space from the sun. Various investigators have attempted to discover a relation between barometric pressure of the atmosphere, earth tides and local disturbances of the crust. Aside from this possible indirect relationship there is no known coordination of earthquakes and the weather.

Nor is there any marked relation between magnetic phenomena and the weather. Magnetic storms, or disturbances in the magnetic state of the earth, frequently occur without any apparent effect upon the weather. That there is a relation between magnetic phenomena in the earth, auroras, and solar disturbances, particularly sunspots, there can no longer be any doubt. The aurora borealis, seen in northern latitudes, and the aurora australis, seen in southern latitudes, are believed to be caused by electrical discharges in the rarefied strata of the earth's upper atmosphere. Aside from the visible manifestations of such discharges, observers have sometimes noticed sounds, and, upon rare occasions, odors

which were thought to have resulted therefrom. However, the aurora has not yet been satisfactorily explained. With the exception of the aurora, there is no known relation between terrestrial magnetism and atmospheric phenomena.

The question as to whether or not forests affect weather and climate has been much debated. Recent investigations have brought out the following facts: Whatever influence forests have upon meteorological conditions is purely local, and even that influence is not marked. In one case it was found that the mean annual temperature within a forest was only a few tenths of a degree cooler than at a point a half mile or a mile outside the forest border, the greatest difference amounting to 2° F. The relative humidity was at times 7 per cent. greater within the forest than in the open country. In the United States the wholesale destruction of forests, which has been going on since colonial times, has not been accompanied by any marked increase or decrease in rainfall. On the other hand, the reforestation of large tracts in central Europe and in northern Africa during the past century has not resulted in an appreciable effect upon the precipitation observed during that period. Forests are the effect rather than the cause. There is still considerable confusion in the public mind concerning rainfall and flowoff, when the supposed influence of forests is considered. Deforestation has undoubtedly increased the frequency and the intensity of floods in small constricted districts, notably in certain mountain valleys, but where the removal of the forest cover over large areas has been followed by cultivation of the soil the rate of flowoff has remained unchanged. From hydrographs of the principal rivers of the United States it is apparent that high waters are neither higher nor low waters lower than they were fifty years ago, and they are neither more frequent nor of longer duration now than they were then. Notable floods like that of Paris, France, during the spring of 1910, and that of the Ohio Valley in the spring of 1913, are the result of a number of causes, in which the excessive rainfall was in no way related to the presence or absence of forests, and in which the rapid flowoff was more dependent upon the frozen soil than upon the recent removal of the forest cover. That the flowoff is more rapid when the ground is frozen explains the greater frequency of floods during spring than during any other season of the year. Moreover, forests tend to preserve the snows of winter, as well as to retain the fertile elements of the soil from washing away. While forests are thus of importance to the agriculturalist and the engineer, they are of little concern to the student of the weather.

The deep-seated notion, held by many individuals, that the climate is changing is often referred to in expressions like "old-fashioned winter," "the storms we used to have," and "the deep snows when I was a boy," etc. Subjective phenomena like these are of inter-

est to the psychologist, and it remains for the meteorologist simply to prove that the notions have no basis in fact. When one plots the seasonal or the annual temperatures or snowfalls, or any other elements of climate, using reliable records as far back as they are available, it is apparent that the curves show no appreciable change of climate within the life of any man now living. The explanation for fallacies of this nature must be given in terms of psychology. Present winters do not seem to be as severe as "old-fashioned winters" because of better housing and heating conditions, more efficient clothing, improved methods of transportation, with multiplied comforts and conveniences. The retired farmer living in a steam-heated city apartment building in which there are double windows is apt to exaggerate the severity of past winters when he may possibly have seen the snow drift through cracks in a log house. Moreover, a snowfall of three feet looks considerably deeper to a boy four feet tall than it does to him when he becomes a man six feet in height.

There is no known relation between the weather of one season or year with that of the following season or year, various opinions to the contrary, notwithstanding. The records of the Weather Bureau do not show that a relatively dry spring is followed by an unusually hot summer, or that an abnormally cool autumn is followed by a severely cold winter. Neither can it be shown that cold years or warm years occur in groups of two or three, as is sometimes maintained. While well-marked cycles are recognized in various solar disturbances, particularly sunspots, there is no similar cycle apparent in the weather of seasons or of years. If there are cycles in the weather they must be measured in terms of tenths of units, and they are therefore of no practical importance.

Neither is there any indisputable connection between the weather of one day and that of subsequent weeks or of seasons. Tradition has it that the presence or absence of sunshine on Groundhog Day, February 2, determines whether or not winter conditions shall continue during the following six weeks; that a showery Easter Sunday is followed by seven showery Sundays; and that a rainy St. Swithin's Day, July 15, portends forty consecutive days of rainfall. No basis can be found for these traditions in available records. True it is that springlike conditions come considerably earlier some years than during other years, but such conditions are not related to the weather of February 2. Moreover, spring and summer are the seasons of greatest and most frequent rainfall over the central portion of the United States, but the frequency of rain is not related to the conditions prevailing on Easter Sunday or on July 15.

In the use of the terms cyclone and tornado there is considerable confusion, and the terms are used indiscriminately. As used by the Weather Bureau the term cyclone refers to an area of low barometric pressure with winds blowing counter-clockwise and spirally inward

toward its center, or point of lowest pressure. Marked "Low" on the weather map, the cyclone is variously called storm, depression, or disturbance. Cyclones vary greatly in size, some being as large as the whole Mississippi Valley, while others are no larger than New England. In the United States they usually move from west to east at an average rate of 300 miles a day, the rate being faster in winter than in summer. In general, the wind velocity varies directly as the barometric gradient, that is, the rate of change of barometer as measured outward from the center. Cyclones are regions of clouded sky, with more or less precipitation, and as they pass alternately with the "Highs" in endless procession across the northern and central portions of the country they produce the frequent weather changes which are characteristic of these regions. In winter, when they are most common and follow the more southerly routes, they bring warm weather at the front and cold weather at the rear. A tornado, on the other hand, is a violent local storm of the thunderstorm type, with whirling and ascending winds of extremely high velocity, causing destructive effects over paths varying in width from a few feet to a few miles. They occur during the summer half-year only, and usually during the hottest part of the day. Not only are they always associated with thunderstorms, but they may be considered overdeveloped storms of that class. While cyclones and tornadoes thus have many common characteristics, custom has identified the use of the terms with certain meanings. Cyclone, as a general term, refers to any whirling mass of air, while tornado, the special term, refers to a particular kind of whirl. However, as used by the Weather Bureau their application is that described above.

The frequent expression in winter that "another storm is brewing at Medicine Hat" seems to be based upon a false association of that station with the origin of our weather. Charts of the weather of the whole northern hemisphere, now made daily at the central office of the Weather Bureau at Washington, show that the cyclones and the anticyclones which determine our weather move from west to east in endless procession. Some of the individual areas may be followed throughout the entire circuit around the earth, while others can be traced for only short distances. Neither Medicine Hat nor any other single station serves as a starting point. However, well-defined storm tracks are now recognized. Certain stations in the Canadian northwest are closely watched for indications of an oncoming storm, which, if it follows the usual route, will enter the northwestern states one to three days later, subsequently passing eastward and finally passing off the Atlantic coast. Because of their positions on the storm tracks, and not because of any center of storm formation, should stations like Medicine Hat be of meteorological interest.

What is popularly known as the equinoctial storm is supposed to

occur about the time of the autumnal equinox, September 21, when the sun crosses the celestial equator to the southern hemisphere. East of the Rocky Mountains rain occurs on an average about once in three or four days, while in the North Pacific states it occurs once in every two or three days, taking the year as a whole. Throughout these large areas the latter part of September is a transition period, with autumn conditions replacing those of summer, and occasionally with the first occurrence of a storm of the winter type. The latter are usually characterized by relatively high winds, rain on two or three successive days, and followed by a considerable fall in temperature. Bearing in mind the average frequency of rainy days and of winter storms, it is apparent that it would be abnormal should no rain occur during the week preceding or the week following September 21. The so-called equinoctial storm is a fiction.

Indian Summer is another popular superstition. Characterized by high temperatures, light winds and calms, and a hazy or smoky atmosphere, it is generally supposed to be a particularly pleasant period of indefinite length occurring in October or November. That there is frequently a return of summer-like conditions during the late autumn can not be denied. But to affirm that Indian Summer is a period of several weeks in duration, recurring each autumn, and easily recognized by the occurrence of heat, calms and haze, can not be proved by climatological records. It is a peculiar fact that while the recurrence of summerlike conditions in autumn has given rise to this tradition, and even the name as a season, the similarly frequent recurrence of winterlike conditions in spring has not been popularly recognized. Summerlike periods in autumn and winterlike periods in spring can in every individual case be explained by the weather map in terms of barometric distribution, paths of storms, resulting winds and calms, the height of the sun, the length of days, and the unequal distribution of heat over the continent and the bordering oceans.

Another false notion, particularly common in rural districts, is the belief that various animals, through some particular dispensation of Nature, have a previous knowledge of coming weather changes. As a result, many proverbs have arisen, based upon observations of the behavior of animals. For example, it is sometimes stated that a cold winter is portended when the musk-rat or the beaver builds the walls of his home thicker than usual, or when the squirrels or the non-migratory birds hide large quantities of food during the autumn. Again, the remark is often made that a storm is imminent when the chickens go to roost early or when the house-cat seeks a warm place beside the fire. Even the human feeling of comfort occasionally gives rise to presentiment. Persons afflicted with recurrent rheumatism claim to feel the approach of a storm long before it appears, and people of

nervous temperament often affirm that they have forebodings of coming thunderstorms or of rainy spells through a temporary disturbance of their neural equilibrium. Physiologically considered, either from the point of view of man or of the lower animals, these fore-warnings, often verified, have some basis for their existence. The secret of the explanation probably lies in the fact that all weather changes occur in cycles—that is, a more or less constant order of events accompanying every change. With the summer thunderstorm this cycle usually consists of the following: rising temperature and humidity, pressure oscillations, decreasing winds, increasing potential of atmospheric electricity, thickening clouds and consequent growing darkness, distant lightning, rumbling thunder, the lightning growing more vivid and the thunder louder and louder as the storm approaches, a squall of wind coming from the direction of the storm itself, accompanied by a marked fall in temperature, inconstant humidity, large drops of rain, followed by a downpour, often accompanied by hail. Another cycle, covering a considerably longer period of time, is recognized as a precedent of the rains of a barometric depression. Men differ greatly from the lower animals in their sensitiveness to these various stages, and even different individuals, whether in the higher or in the lower orders of animal life, show wide divergence in this respect. As a result, sensitive persons and certain animals feel a coming change because for them the change has already begun, they feel the rising humidity or the changing pressure before others, and they are, in fact, simply changes usually precedent to the larger changes observed by all. However, one or more of these changes may occur without reference to the various other changes, thus explaining why the premonitions are sometimes amiss. But cycles of this nature occur so frequently that traditions of a fair degree of reliability have arisen. It might be added that most of the reliable proverbs based upon the behavior of animals are ultimately concerned with changes of humidity. To such changes certain animals appear to be super-sensitive, while most men are phlegmatic in this respect.

That rain has resulted from the concussions attending the old-fashioned celebration of Independence Day (July 4) or during great battles, particularly those of the Civil War, has long been a popular belief. Even before gunpowder was used for military purposes it was held that rain was produced by the clashing of swords and armor in physical combat. The explanation offered was to the effect that widespread concussions caused the small vapor particles floating in the air to coalesce to form raindrops, the dust and smoke furnishing the necessary nuclei of condensation. Records obtained in all parts of the United States and covering long periods of years fail to show that precipitation is heavier or more frequent upon July 4 or 5 than it is upon July 2 or 3. Moreover, so far as the records are available, the rain

accompanying or immediately following great battles is not unlike that which might have been expected in the course of natural events. Bearing in mind the fact, already stated, that throughout large areas rain occurs on an average once in three or four days, and also the subjective fact that rain associated with July 4 celebrations or with battles would doubtless not have been remembered had it not been for such associations, the hypothesis appears to have no foundation. In 1892 the U. S. Government disproved the idea by experiments in which violent explosions of dynamite were produced within clouds by means of kites and balloons, with no rain following as a direct or even as an indirect result. The practise, still followed in various European countries, of attempting to prevent hail by bombarding approaching clouds or of projecting vortex rings of smoke upward, also is without scientific basis. The relatively feeble convectional currents resulting from these artificial attempts to influence the weather are too meager to have any appreciable effect upon the massive convection accompanying storms and are wholly inadequate to influence precipitation.

It is often maintained that cold waves are produced by a descent of cold air from aloft. While it is true that the air aloft is colder than that at the ground, and that up to a height of about six miles there is a more or less uniform decrease of temperature with increase of height, cold waves owe their origin to a number of factors. Nearly all cold waves of the United States occur in the area forming the rear of a passing cyclone and the front of an approaching anticyclone. During the winter half-year this region is characterized by relatively strong northerly or northwesterly winds, clearing skies, decreasing humidity, and the conspicuous fall in temperature. There is a distinct gyratory movement in large disks of air, clockwise, outward from the center, and to a slight extent descending, in the anticyclone, while it is counter-clockwise, inward toward the center, and to some degree ascending in the cyclone. The sharp fall in temperature forming the cold wave is caused primarily by the horizontal transportation of huge masses of cold air from the cold continental interior, and is heightened by the increased radiation from the ground through clear, dry air thus brought in. Vertical currents are probably only of secondary importance in this connection.

In comparing the climates of different places too much stress is generally laid upon mean, and not enough upon extreme conditions of the weather. For example, the average annual temperature, often the only climatological fact quoted in the description of a place, may be very deceptive. Based upon the records of 33 years, the mean annual temperatures of Washington, D. C., and San Francisco, Cal., are practically the same, being 54.7° F. and 54.9° F., respectively. The climates of the two cities are greatly unlike, however. Washington has a semi-continental climate, with daily maximum temperatures in sum-

mer often exceeding 90° F., and minimum temperatures in winter frequently going below 0° F. San Francisco, on the other hand, has a semi-tropical climate, with temperatures of 90° F. or over occurring but two or three times in a year, and minimum temperatures below 40° F. being equally rare. In addition, the climates of the two cities differ greatly in respect to the amount and duration of sunshine, cloudiness, rainfall, relative humidity, wind velocity and direction, and the various other elements which constitute climate. The mean annual temperature is therefore an inadequate indication of climatic conditions, and can not alone serve as a basis of comparison.

Too much emphasis is also placed upon the temperature itself—our feeling of comfort is by no means entirely dependent upon the reading of the dry-bulb thermometer. An ideal curve of comfort might show but little resemblence to the thermograph trace. Relative humidity is so important a contributory factor that the wet-bulb rather than the dry-bulb thermometer is often the better indicator. The feeling produced by a temperature of 100° F. experienced in southern Arizona is wholly unlike that accompanying a similar temperature in an eastern city, the difference being due primarily to the marked difference in relative humidity. Other factors also affect one's feeling of comfort, such as sunshine, wind velocity, barometric pressure, and atmospheric electricity. Some time it may be possible to give correct relative weights to each of these factors in determining their effect upon the man in perfect health. While temperature doubtless will receive the greatest weight, the other factors are by no means negligible.

Night air is occasionally referred to as though it is different from day air, and convalescents are sometimes urged to avoid it as dangerous. While there are obvious physical differences between night air and day air there is little diurnal change in chemical composition. Atmospheric air is a physical mixture which when perfectly dry consists principally of nitrogen, oxygen, argon, and carbon dioxide, in which the relative proportions remain fairly constant, and in which the first two named constitute more than 99 per cent. by volume. Up to heights greater than the summits of the highest mountains the percentage of oxygen, an element necessary in the respiration of both plants and animals, shows no appreciable variation. Carbon dioxide, however, which forms but .03 per cent. by volume, or .05 per cent. by weight, of the air, shows both an annual and a diurnal variation. By volume it is 23 per cent. greater in summer than in winter, and is 12 per cent. greater at night than during the day. Since carbon dioxide does not become dangerous until it constitutes considerably more than 1 per cent. of the air we breathe, the change from day to night can not account for the supposedly offensive feature of night air. Water vapor, which never exceeds 4 per cent. by volume of atmospheric air, is important as far as

respiration is concerned, because of the diurnal change in relative humidity, the change usually being inversely as the temperature. The actual amount present, however, does not change greatly from day to night. If therefore, night air is dangerous for convalescents, and it probably is not, it is because of physical and not chemical differences between it and day air.

The importance of ozone as a constituent of the atmosphere is popularly overestimated, and the numerous advertisements referring to it as the basis of the health-giving qualities of the air at certain resorts are largely a delusion and a snare. In a molecule of ozone, one of the allotropic forms of oxygen, three atoms of oxygen are held together in such a way that there is but feeble chemical attraction of two atoms for the third atom, which readily leaves the other two to form a compound with some other element. It is because of the latter characteristic that ozone has its peculiar properties. Though there is considerable diurnal and annual range in the amount present in the atmosphere, and also a large difference between that of the air in cities and that in the country or in the free air, the relative proportion, in general, is but one part in a million. In nature it may be formed (1) by lightning discharges, thus explaining the unusual odor sometimes perceptible immediately after a thunderstorm, (2) by the evaporation of water, particularly in clouds or near waterfalls and fountains, and (3) the action of ultra-violet light upon oxygen, probably most effective in the free air above the highest cloud level. However, the healthful properties of the air at various resorts is due primarily to the dryness of the air, the relatively low temperature with small diurnal and annual ranges, the absence of dust and smoke, and the increased amount of atmospheric electricity, and only secondarily to the larger amount of ozone present in the atmosphere.

Since the sun is ultimately the source of all the heat of the atmosphere the question is sometimes raised: "Why is not the upper air, being nearer the sun during the day, warmer than the lower air, which is more distant; in other words, why is there not an increase rather than a decrease in temperature with height?" Records obtained by means of kites and balloons show, among other things, (1) that up to a height of about 6 miles there is a more or less uniform decrease of temperature with height, (2) that the density of the atmosphere decreases rapidly with height, it being half as dense at a height of 3.5 miles as it is at sea level, and (3) that the water vapor is limited to the lower strata, 80 per cent. of it being below a height of 3 miles. The last two conditions explain the first. Partly because of the adiabatic rate of decrease of temperature of a gas with a decrease of its density, and partly because of the ability of water vapor to remove and to store

heat energy from the solar rays, the lower atmosphere is warmer than the higher atmosphere.

The source of the water which falls in the form of rain or snow in the United States is erroneously stated in several geographical textbooks to be the Pacific Ocean. Such a statement is doubtless based upon the delusion that the United States, located in a region of prevailing west winds, naturally should receive precipitation from the air which has been moving for thousands of miles across the Pacific, and therefore must have accumulated as much moisture as its temperature will allow it to carry. As a matter of fact, by far the greater proportion (one authority says 90 per cent.) of our precipitation has its source in the Gulf of Mexico and in that part of the Atlantic Ocean lying directly east and southeast of the continent. West of the Rocky Mountains the precipitation comes ultimately from the Pacific, but as the rainfall throughout this large area is deficient, except in western Washington and Oregon, the sum total is small compared with that of the nation as a whole. General and widespread precipitation accompanies the passage of a barometric depression, where the winds in its front, blowing from points between northeast and south, discharge a part of their load of water vapor in the form of rain. The condensation is brought about primarily through the cooling air compressing some of its moisture from it, the lowering temperature being caused by a passage of the air from the relatively warm Atlantic or Gulf to the relatively cold continental interior in winter, or from ascending, expanding, and therefore cooling air during summer. Even so large a water surface as that of the Great Lakes contributes but little to the total rainfall of the United States.

Northeast storms, a characteristic feature of the winters of the Middle and the North Atlantic States, do not come from the northeast, as many infer. The strong, northeast, rainbearing winds do, it is true, bring their loads of moisture from the Atlantic Ocean, but they are simply the indraught of a barometric depression which the weather map shows has come from the west or southwest, usually along a well recognized track. Only upon rare occasions does a storm travel from east to west in these latitudes, and storms of this type, called "flarebacks," are still a stumbling-block in weather-forecasting. In general, a storm or barometric depression is accompanied by winds blowing in a counterclockwise direction and spirally inward toward the center. An examination of the weather map when a northeast storm is in progress will show that the center of the disturbance is southwest or west of the observer, the winds backing to northwest when the center subsequently passes close by or south of the point of observation in its easterly or northeasterly movement.

The tradition that the climate of a city is very different from

that of the surrounding country, while partially true, is often exaggerated in the public mind. According to Professor J. Hann, unquestionably the leading authority on climate, city temperatures differ from those of the open country nearby in the following respects: The mean annual temperature of the air in places where there are many buildings in from 1° to 2° F. too high, the differences being greatest in the morning and evening, and least at noon. The diurnal range is smaller in cities, especially in summer. The cooling by radiation, at night, is much greater in the open than in places which are built up. The cooling due to evaporation probably also plays a part. While it has been calculated that the burning of gas and coal in London develops sufficient heat to have an appreciable effect upon the temperature of the air in a stratum 100 feet thick over that city, no progressive increase in the mean temperatures of New York City and Boston can be found to form a parallel with the growth of those cities. The absolute winter minima are much less marked in the interior of cities than in the surrounding open country. A study of certain cold waves showed that the absolute minimum temperatures recorded in the cities of Toledo, Cleveland, Columbus, and Cincinnati, Ohio, were 20° to 25° F. higher than those noted in the country surrounding these cities. From this the investigator concluded that it would be well to put weather stations near, rather than in, large cities, and at a sufficient distance from them to be free from purely local conditions. It should be added that the temperature felt in the city, under the influence of the radiation from the heated walls of buildings and the reflection from the bare ground, is very different from that felt in the country. Other meteorological elements which show difference between city and country are sunshine, which, on account of smoke, is somewhat less in cities than in the surrounding country, and wind velocity. Every large city has one or more tall buildings about which the wind blows with frequent and violent gusts, even on comparatively calm days. As there is everywhere a rapid increase in wind velocity with height, the taller buildings tend to bring down the higher velocities from aloft. It is thus apparent that there is some degree of difference between the climate of city and country, but when due allowance is made for actual and sensible differences, the effect of the local control upon climate is seen to be small.

Concerning the course followed by a thunderstorm, there are many and varied misconceptions. It is often remarked that a thunderstorm, upon coming to a river valley or a mountain gorge, will divide into two parts, one moving up and the other down the valley, in other words, that thunderstorms tend to follow valleys. Another statement is to the effect that the center or most severe part of the storm passes not over the point of observation, but at some distance away. Instrumental observations fail to verify these and similar generalizations.

From a study of individual storms based upon the records of many stations it has been found that thunderstorms are most frequently formed in the southern half of a cyclone, where warm and light southerly winds are superimposed by cold and heavy northwesterly winds. In the restoration of equilibrium between these horizontal air masses there is violent vertical convection, accompanied by lightning, thunder, heavy rain, and occasionally hail. Though called local storms they usually advance along well defined convex wave-fronts, which measure from 50 to 200 miles in length, moving broadside in an easterly direction across the country, at about the rate of a fast express train. The horizontal breadth of this line varies from 10 to 30 miles, while the vertical convection extends to heights 5 miles or more above the ground. When one considers the vastness of the mass of air in violent agitation in one of these storms it is apparent that the topography of the ground can have no appreciable effect in determining the course of the storm. Certain it is that throughout the central and eastern parts of the United States, where thunderstorms are a characteristic feature of summer weather, the ground relief is insufficient to influence the courses. Nor is there any foundation for the belief that the storm has a center of extreme violence, which is usually stated to have passed a point either north of or south of the observer. When the storm line is passing an observer from west to east, perspective causes the cloud to appear darker to the north and the south, rather than in the front or the rear of the storm, or even overhead.

Tradition has it that "lightning never strikes twice in the same place." The idea is not only without scientific basis, but the opposite may be nearer the truth, for if the conditions which attracted a lightning discharge are not disturbed by such a discharge there is great probability that they may attract the lightning a second time. In general, any good electrical conductor projecting above material which offers resistance to the passage of electricity will tend to attract lightning. If this projecting conductor is insulated from surrounding material and is anchored deep in the soil, down in the level of permanent moisture, the conductor will protect the surrounding objects. This is the theory of the lightning-rod, which, when properly installed, is a good protector. Though it does actually attract the lightning it may be struck any number of times without damage to things nearby. The Eiffel Tower, in Paris, France, a steel tower 1,000 feet high, has often been struck, six times during the passage of one particularly severe storm. As ample provision is made to conduct the electricity to the earth no serious destruction has resulted. The tradition "lightning never strikes twice in the same place" is therefore more nearly correct when the word never is omitted.

That freezing temperatures are necessary for the formation of hail

has sometimes led people to conclude that the hailstones must have necessarily come from the far north, falling as they do on days when the heat has been oppressive. True hailstones occur only with storms of the thunderstorm type, where violent convection extends to heights of five miles or more above the ground. Here the ascending currents are occasionally so strong that they carry aloft, far beyond the level of permanent freezing temperature, particles of moisture already condensed into raindrops. In the average, there is a fall of temperature of 1° F. for every 300 feet of height, so that even in midsummer, when the temperature at the ground is 90° F., one has to ascend but $3\frac{1}{2}$ miles to encounter a freezing temperature. The water droplets, solidifying upon entering the freezing stratum of air, later fall to lower levels, where they may again be caught up by ascending currents to the colder strata above. This process may be repeated a number of times, with the result that the hailstones, upon finally reaching the ground, will show concentric layers of ice and snow. The moisture content more probably came from the Atlantic Ocean, to the east, or the Gulf of Mexico, to the south, rather than from the far north.

The development of meteorology and climatology has been so recent that the general public has not kept pace with the progress. While there are thousands of weather proverbs which are correct generalizations of weather observations extending over many years, a number of traditions have persisted which are apparently without scientific foundation. A few of these, originating in European countries, and doubtless true in their native environment, have proved inapplicable when imported to America. Others are inadequate as they make no distinction between the real and the apparent—between the objective and the subjective. Still others are found wanting because they are based upon fallacious ideas. Instrumental observations, laboratory experiments, and the exploration of the free air have exposed many more misconceptions. Though we have made but a small beginning in a systematic science of the weather, we have advanced far enough to make it possible to eliminate some of the earlier preconceived notions.

DUCTLESS GLANDS, INTERNAL SECRETIONS AND HORMONIC EQUILIBRIUM. III

By FIELDING H. GARRISON, M.D.

WASHINGTON, D. C.

IV

THE most remarkable fact about the internal secretions is that they are correlated with one another. Not only has this been abundantly demonstrated by experiment, but, in many cases, pathological lesions of the individual glands cause some disturbance in the functional relations of the other glands—the so-called "pluriglandular syndromes." The idea of a correlative relation is not necessarily new, was perhaps implicit even in Bordeu's statement of the theory, but it did not begin to acquire tangible and intelligible form until the complex chemistry of the metabolism of the body had beeen better understood. On the physiological side, it has been noted, for instance, that excision of the pancreas produces glycosuria, even after thyroidectomy and parathyroidectomy, but not after excision of the adrenal bodies; that partial excision of the thyroid in bitches will produce a mild myxœdema, if pregnancy supervenes, the symptoms disappearing after littering; that the thymus gland is often enlarged in exophthalmic goiter but will atrophy after thyroidectomy; that castration is followed by enlargement of the thymus, and, conversely, excision of the thymus produces swelling of the ovaries. On the pathological side, the thyroid is often enlarged during puberty, menstruation, excessive venery (*e. g.,* in prostitutes) and pregnancy; swelling of the ovary and menstrual disturbances often accompany goiter. Myxœdema often comes on at the menopause or in connection with sterility. Acromegaly, as was shown by Edwin Klebs, is often accompanied by enlargement of the thymus. Enlargement of the pituitary often accompanies pregnancy or hibernation, yet castration causes enlargement of the pituitary in the young and acromegaly is often associated with loss of sexual power. The fact that many of these experimental results and pathological findings do not harmonize makes the problem one of extreme complexity. Furthermore, it is known that lesions of different ductless glands will produce isolated identical effects, which overlap each other in a group of symptoms, making the causal relation dubious when there is a "pluriglandular syndrome." Glycosuria (lowered tolerance for carbohydrates) may be produced by goiter, by injection of thyroid extract in acromegaly or by injection of pituitary extract, by excision of the parathyroid body, by

injection of adrenalin, by excision of the pancreas or by a lesion of the islands of Langerhans in that organ. On the other hand, an increased tolerance for carbohydrates (obesity) occurs after destruction of the posterior lobe of the pituitary body, as well as in myxœdema or after thyroidectomy; increased blood pressure follows upon injection of the pituitary, adrenal, placental and kidney extracts; lactation is accelerated by injection of extracts of the thymus, pineal and pituitary bodies and the corpus luteum (ovary); the pupil is dilated by extracts of the thymus, pituitary, pancreas, suprarenals, kidney, sexual glands, liver and muscle. Effects of this kind are analogous to the mystifying "enharmonic cross relations" in modern music, in which the same note (on the piano scale) is so employed that it is brought into relation with two different tonalities. C sharp and D flat, G sharp and A flat produce the same sounds when given on the piano scale, although they can, if necessary, be distinguished on stringed instruments, which render an exact account of the difference in the number of vibrations. Similarly, these apparently identical effects of the different ductless glands indicate that their functions are correlated, that they are somehow concerned in maintaining the hormonic equilibrium of the body.

Concerning the mechanism of correlation, two prominent theories have been advanced. The first is the doctrine of the hormones of Bayliss and Starling (1902) in which the chemical control of the body is assumed to be effected by means of hormones, or chemical messengers, which pass from the various organs and ductless glands, *via* the bloodstream, to other parts of the body, producing biochemical effects upon irritable protoplasmic tissues. In the initial experiment of Bayliss and Starling, the secretion of pancreatic juice following upon introduction of acid into the duodenum was found to be not a local reflex, as had hitherto been assumed, but due to the action of a hypothetical substance (secretin) discharged by the intestinal mucous membrane under the influence of the acid and carried to the pancreas by the blood channel. Many experiments, particularly those of Howell on the coagulants and anticoagulants of the blood (thromboplastin and antithrombin) indicate the existence of hormones. Adrenalin, iodothyrin and pituitrin are the only hormones of the ductless glands which have been isolated to date.

The other theory is that of the clinicians and pharmacologists of the Vienna school, Eppinger, Falta and Rudinger, which asserts that the suprarenal and thyroid bodies act upon and are controlled by the nerves of the sympathetic system, while the pancreas is similarly related to all nerves acting upon smooth (involuntary) muscle and not originating from the chain of sympathetic ganglia. The two systems have been termed "autonomic," because they seem to be detached from and independent of the controlling impulses arising from the cerebro-

spinal axis, while themselves controlling all organs containing unstriped muscle, secreting glands or both, *e. g.*, the smooth muscle of the bronchi, stomach, intestines, blood vessels, genitalia, eye and all the glands of external and internal secretion. The sympathetic or visceral nervous system has also been called the "vegetative" system, because the organs under its dominion functionate involuntarily or unconsciously, as with vegetables or plants. At present, the term "vegetative system," formerly termed the autonomic system by Langley, is restricted to that part of it which originates from the sympathetic ganglia, while the antagonistic system governing involuntary muscle, which is largely made up of fibers from the vagus nerve, is now styled the "vagal autonomic."

The difference between the two autonomic nervous systems and the central (cerebro-spinal) system is that, in the former, the nerve fibers never proceed, as ordinarily, directly from the nerve center to the organ controlled, but pass, as neurons, from the gray substance to a ganglion in which they encounter a break or synapse (separating surface), on the other side of which a similar post-ganglionic neuron proceeds to the organ controlled. The synapse, a term first proposed by Sir Michael Foster, has been likened to a switch over which the nervous impulse jumps to proceed on its way. Langley, the original investigator of the autonomic systems, discovered that wherever there is a switching of the nervous impulse across a synapse; the effect can be abolished in other words the post-ganglionic fiber can be paralyzed, by painting over the exposed ganglion with nicotine solution, thus determining whether an autonomic nerve fiber passes through a ganglion without interruption or not. If, after painting the exposed ganglion with diluted 0.5 nicotine solution, or even after internal administration of the alkaloid, the effect of central excitation of the post-ganglionic fiber at the ganglion is the same as ordinarily, then there is no interruption; but if the effect is abolished under these conditions, then the pre-ganglionic fiber terminates in a synapse. Langley's nicotine effect holds good for all ganglia of the autonomic systems, whether of sympathetic or vagal origin. In other respects, however, these two systems are antagonistic, both in respect of physiological functions and response to the action of drugs. The effect of electrical stimulation of a sympathetic fiber is just the opposite of that of a vagal autonomic fiber. The sympathetic fibers check, the vagal autonomic fibers excite, the movements of the intestines; the sympathetic dilates, the vagal autonomic contracts, the pupil; the sympathetic hastens, the vagal autonomic slows, the heart. Adrenalin (epinephrin), which the Viennese clinicians assume to be the specific hormone of the sympathetic autonomic, produces, on ingestion or injection, effects similar to those produced by electrical

stimulation of the sympathetic, viz., dilatation of the pupil, dry mouth from diminished salivary secretion, rapid heart action, glycosuria and increased secretion and motility of the stomach and intestines. Hence adrenalin, and drugs, like ergotoxin, which resemble it in action, are variously termed sympathicotropic, sympathicotonic or sympathicomimetic. On the other hand, certain drugs, such as pilocarpin, muscarin, physostigmin, cholin and digitalis, which stimulate the autonomic fibers of the vagus, producing effects diametrically opposite (contraction of the pupils, profuse salivation, slow heart action, pollakiuria, etc.) are termed vagotropic, vagotonic or vagomimetic, because their action simulates the vagal autonomic. Thus the Viennese clinicians postulate two opposing diathetic conditions, sympathicotonus and vagotonus, the symptomatology of which can be thrown into relief by certain pharmacodynamic tests, which have been likened by Januschke to "tuning keys by means of which we can operate upon the complicated stringed instruments of the body, and voluntarily make one string tighter to increase its vibration or another looser to dampen its function."[25] To complete the analogy of their tripod of ductless gland correlations, Eppinger and Hess assume that the pancreas, controlled by the vagal autonomics, secretes a hormone "autonomin," which is supposed to antagonize adrenalin, the hormone of the sympathetic system proper. So far, this is a very cogent and fascinating theory, but, as often happens, it does not work out according to specifications in all cases, and is strongly opposed by Gleg. The symptomatology in vagotonic and sympathicotonic patients, too complex to be considered here, is extremely variable and the reaction to drugs sometimes unreliable. Thus, Eppinger and Hess themselves found that pilocarpin and adrenalin sometimes produce strong reactions in the same patient. The interest of their theory for present purposes lies in its capacity for elucidating the action of the ductless glands and internal secretion, for behind the ductless glands and the hormones themselves there must be some controlling mechanism. It is assumed that when the vegetative and vagal autonomics are over-excited (sympathicotonia, vagotonia), these act upon the viscera and the ductless glands, the hormones or internal secretions of which in turn react with redoubled force *via* the blood channels upon the autonomic nerve centers, vegetative and vagal, producing a vicious circle, as Hemmeter maintains.[26] Thus the hormones of the viscera and the internal secretions of the ductless glands regulate the tonus of the nervous system, while the autonomic nerve fibers themselves regulate the action of the ductless glands, the viscera, blood vessels and all organs containing involuntary muscle.

[25] Cited by Barker.

[26] J. C. Hemmeter, *New York Med. Jour.*, 1914, XCIX., 108.

The importance of the subject in relation to clinical medicine has been well emphasized by Professor L. F. Barker.[27]

In how far those sudden and violent excitations of the autonomic nervous system which accompany strong emotions are due to the intervention of the glands of internal secretion, and in how far they depend upon direct neural conduction from the brain, we are as yet but ill-informed. I need only remind you of the vasodilatation of the face in the blush of shame, of the stimulation of the lacrimal glands which yields the tears of sorrow, of the palpitation of the heart in joy, of the stimulation of the sudoriparous glands which precedes the sweat of anxiety, of the stimulation of the vaso-constrictors, the pupil dilators and the pilomotors in the pallor, mydriasis and goose-skin of fright, to illustrate some of these violent autonomic excitations. While we do not yet understand the exact mechanisms of association among the activities of the cerebrum, the endocrine glands and the reciprocally antagonistic autonomic domains and their end-organs, we can begin to see the paths which must be followed in order that more exact knowledge may be gained.

The balance maintained normally between the two antagonistic systems is one of the most interesting of physiological phenomena. Think, for example, of the rate of the heart beat—how constantly it is maintained at a given level in each individual when the body is at rest; the impulses arriving through the vagal system just balance those arriving through the sympathetic system, so as to maintain a rate of approximately seventy-two beats per minute. And a similar balance is maintained in other autonomic domains (*e. g.*, pupils, bronchial musculature, gastric glands, gastro-intestinal muscle, sweat glands, bladder muscle, etc.).

This equilibrium is all the more remarkable when one considers how frequently it is temporarily upset in the exercise of physiological function. The play of the pupils with varying light, the watering of the mouth at the smell of savory food, the response of the heart to exercise and emotion, the flow of gastric juice on adequate stimulation, the opening of the bile duct at the call of the chyme, the transport of the colonic contents through one third of the length of the colon through one vehement contraction every eight hours, the sudden relaxation of the sphincter and contraction of the detrusor of the bladder in micturition, the violence of contractions in the domain of the N. pelvicus in parturition in the female and in the ejaculation in the male, come to mind at once as examples of sudden physiological overthrow of balance.

Another set of correlations advanced by the Vienna school is connected with the causation of diabetes. Eppinger, Falta and Rudinger regard the thyroid, pituitary and adrenals (chromaffinic system) as the accelerators or mobilizers of glycosuria, in that all three increase exchange or metabolism of proteins, the adrenals mobilizing carbohydrates and the thyroid increasing fat absorption. The pancreas and the parathyroids, on the other hand, are held to be inhibitors of glycosuria, retarding protein metabolism and restricting the mobilization of carbohydrates. Diabetes following excision of the pancreas is held to be due to the mobilizing power of the adrenal hormone on the

[27] L. F. Barker, *Canadian Med. Assoc. Jour.*, Montreal, 1913, III. See, also, W. B. Cannon, "The Interrelations of Emotions as Suggested by Recent Physiological Researches," *Am. Jour. Psychol.*, Worcester, Mass., 1914, XXV., 256–282.

glycogen of the liver, the normal inhibitory action of the pancreatic hormone being removed, and is thus at once a positive adrenal diabetes and a negative pancreatic diabetes. This harmonizes with the glycosurias following injection of adrenalin or following increase of the adrenal function from stimulation of the sympathetic system. Hyperthyroidism (exophthalmic goiter) produces a tendency to glycosuria from relative pancreatic insufficiency and increased adrenal activity. Myxœdema or the corresponding removal of the thyroid gland produces an increased tolerance for carbohydrates (obesity) because the inhibitory function of the pancreas is removed and adrenal action diminished. There is a lowering of carbohydrate tolerance after parathyroidectomy. The lowered carbohydrate tolerance in hyperpituitarism and the increased tolerance in hypopituitarism, demonstrated by Cushing, is explained by the inhibitory action of the secretion of the posterior lobe of the pituitary on the pancreatic hormone, mobilization of glycogen and glycosuria resulting when the pituitary secretion is in excess and the restraining influence of the pancreas thus impaired. Cushing and Jacobson found that the obesity or high sugar tolerance following excision of the posterior lobe of the pituitary will persist even after subsequent excision of the pancreas, no glycosuria developing.

The question arises, how do the internal secretions or hormones act upon the central nervous system? Here we encounter what Ehrlich calls that obscure province of physiology, the specific irritability of organized tissues, or the capacity of protoplasm to react to chemical and other stimuli. If a chemical substance in the blood comes in contact with the chemoreceptors or special groups of atoms in the periphery of a cell, the two sets of substances may remain inert in relation to each other, they may combine, producing equilibrium, or they may induce a vigorous reaction through difference in their chemical potentialities. The complexity of this phase of the subject is fairly indicated in Abderhalden's studies of intracellular metabolism, in which he shows that by linkage of three different amino acids, *A, B, C,* the following isomeric arrangements can be produced by permutation and combination, viz.,

A-B-C *A-C-B* *B-A-C* *B-C-A* *C-A-B* *C-B-A.*

In like manner, from linkage of four amino acids, 24 structurally isomeric compounds may result, from five, 120; from six, 720; from seven, 5,040; from fifteen, 1,307,674,368,000; from twenty, 2,432,902,008,176,640,000. We have as yet no calculus of variations fine enough to estimate even the rate of change of these evanescent combinations, which we may assume, are constantly taking place within the cell.

Again, it may be asked, is the hormonic equilibrium of the body identical with thermodynamic equilibrium? And here we have another problem which may be described as transcendental. In the ordinary

metabolism of the body, it is agreed that the first law of thermodynamics—conservation of energy or constancy of the sum of energy in an isolated system—applies in every respect. Does the second law—irreversible dissipation of energy in one direction—apply to such relatively isolated (adiabatic) systems as a cell enclosed in its cell-wall or the animal body encased in its integument. Does the cell or the organism act like a heat engine or an electric cell, dissipating its energy in one direction, or is it a reversible mechanism, like a dynamo. In the animal body, the food stuffs of high chemical potential, proteids, carbohydrates and fats, are degraded and transformed into substances of low chemical potential (carbon dioxide, urea and water), the energies passing, as in a Carnot cycle, from a source of high potential to a sink at low potential energy. The second law is operative here, but the process is more economical than in a heat engine. Still more economical is it in cold-blooded animals, while in green plants there seems to be an actual reversal of the process, in that substances of low chemical potential (nitrogen compounds, carbon dioxide and water) are transformed into substances of such high chemical potentiality as carbohydrates, proteids and oils. There is thus some indication that in plant cells, or those organisms, like bacteria, which lie between animals and plants, there is a possibility of reversal of those physical processes which take place in inanimate nature. Of this we have further examples in the nitrification of the soils by bacteria buried in it (without the aid of radiant energy from the sun) or in the Brownian movements of bacteria contained in a liquid.[28] Of the possibility of reversing the second law in the human organism Lord Kelvin said that "even to think of it, we must imagine men with conscious knowledge of the future, but no memory of the past, growing backwards and becoming again unborn, and plants growing downwards into the seeds from which they sprang." This would assuredly be an extreme case, but Cushing's production of sexual infantilism in dogs by partial excision of the anterior lobe of the pituitary body fulfils some of these conditions. At best, we can only affirm that the whole matter is transcendental, that is, so far beyond our ken, since it involves an assumption of the old metaphysical "vital principle," which Bergson revamps as the *élan vital.*

A very complex view of the internal secretions and hormones is that which connects them with the general protective mechanism of the body. The earliest to advance this view was Dr. Charles E. de M. Sajous, of Philadelphia, whose treatise on the internal secretions, published in 1903, has passed through six editions, and has undoubtedly played a prominent part in bringing the subject to a focus in this country. In relation to immunity, Sajous's main position is that the

[28] See J. Johnstone, Proc. and Tr. Liverpool Biol. Soc., 1913, XXVII., 1–34.

germicidal and antitoxic substances in the body are originally derived from certain ductless glands, the immunizing mechanism in question comprising the "adrenal system" (adrenals, pituitary and thyroid). He holds that the adrenal secretion mobilizes zymogens in the body, endowing them with their ferment-activities, that secretin is "adrenoxidase," that enterokinase is adrenoxidase plus nucleo-proteid, that the pituitary body has no internal secretions, but is the general and governing center of the sympathetic system and of all vegetative functions, that, as an immunizing center, it is the homologue of the "test organ" of mollusks and other invertebrate animals, and that the body at large is protected from disease by an "auto-antitoxin" composed of the internal secretions of the adrenal (adrenoxidase; Ehrlich's amboceptor), of the pancreas (trypsin; Ehrlich's complement), of the spleen and leucocytes (nucleoproteid), and of the thyroid and parathyroids (thyroiodase; Wright's opsonins). Upon this theoretical substructure, which was arrived at by deductions based upon clinical and experimental data, including some of his own, the work of a mind of mathematical cast, Sajous has erected a complete system of medicine, connecting his ideas with all known diseases and their treatment.[29]

Without presuming to discuss the merits of these different views, it may be said that their very complexity indicates that present knowledge is in a state of flux and that only the surface of the subject has been scratched so far. We can not object that "facts not opinions" are wanted here, for the collective mass of observations and experiments is enormous. But all recent investigations, those of Abderhalden on the protective ferments of the body, for instance, indicate a general reaching out for a larger correlation or synthesis, which shall weld so many seemingly contradictory observations into a harmonious whole. In 1912[30] von Behring included as "agents of infection," pathogenic microorganisms and their toxic products and the poisons produced by animals (venoms, etc.) and the higher plants (abrin, ricin, ergotin, etc.), and it would seem even reasonable to include in this group certain mineral poisons like arsenic or lead, the action of which mimics an infectious disease. In February, 1914[31] von Behring made another generalization of equal sweep, in which he brings such concepts as idiosyncrasy, susceptibility to disease, diathesis, anaphylaxis and supersensitiveness to toxins into one and the same category. The Viennese clinicians associate diathesis with the ductless glands. Sajous associates the ductless glands with immunity from disease. This is all that can be affirmed of present theories of the subject.

[29] Sajous has given a recent presentation of his views in *American Medicine,* Burlington, N. Y., 1914, XX., 199–210.

[30] E. von Behring, "Einführung in die Lehre von der Bekämpfung der Infektionskrankheiten," Berlin, 1912.

[31] *Schmidt's Jahrb.,* Bonn, CCCXIX., 113–124.

Perhaps the most interesting feature of the ductless glands is their correlation with the sexual function. It is plain that, except as generic types, these categories have no special application to normal humanity. The dunce's cap is surely ready for him who confuses physiological tendency with individual morality, in each case an artificial inhibition put upon reaction to stimuli. Aside from the other correlations, diminished sexual power is common to the two main groups of pituitary disorders, acromegaly and sexual obesity or infantilism. The acromegalics have been likened to the Neanderthal man, who was probably, as the gorillas are, hyperpituitary (Keith), to eunuchs, who are excessively tall when not over-corpulent, and to the tall, raw-boned, heavy-jawed peoples of the northern countries who are often sexually cold. The obese infantile patients of the Fröhlich type, on the other hand, suggest the fat boys of the Pickwick Papers and the large hotels, and the eunuchoid "Lobengulas" described by Sir Jonathan Hutchinson.[32] Even in folk-lore, obesity always connotes sexual frigidity.[33] In a recent view of Dr. Leonard Guthrie, the autopsy of the great Napoleon at St. Helena indicates that the corpulence of his later years, his gradual loss of intellectual keenness, his general fat-headedness from the time of the Russian Campaign, may have been due to the onset of a pituitary obesity, the dystrophia adiposo-genitalis of Mohr and Fröhlich.[34] The logical opposite of the acromegalics are therefore, not the fat patients of the Mohr-Fröhlich type, but the short, swarthy, goat-legged achondroplasics who often exhibit great muscular strength, unusual sexual precocity and general salacity. These have been assimilated to the satyrs of mythology to the short, swarthy, troglodyte peoples such as the Iberians, or the Euskarians, the primitive inhabitants of Britain, to "the short-limbed children, of precocious sexuality," and particularly the "forward female children, with full busts, already boasting of their affairs,"[35] who are so common on the streets of modern cities. It was not without reason that the Greeks represented the great god Pan as a goatish individual. Except in the negro the generic sexual type, the differential characters of which are harped upon even in the plays of Dumas *fils,* is short, swarthy, muscular; the frigid type, of high pituitary index, is either flabby and obese (the *kühle Blonde* of the Germans) or the lank, raw-boned acromegalic. It is said that many achondroplasic dwarfs of history, like Sir Geoffrey Hudson, were of the salacious type. The records of the obstetric clinics show that female achondroplasics, married or unmarried, have sometimes undergone the operation of Cæsarean section three or four times run-

32 See, *Univ. Med. Record*, London, 1912, I., 119–121.

33 "*Ein gutar Hahn wird pelten fett,*" etc.

34 F. Guthrie, Proc. XVII. Internat. Cong. Med., 1913; London, 1914, Sect. XXIII., 143–154.

35 *Univ. Med. Record,* London, 1912, I., 121.

ning. The amazing fertility of achondroplasic women has been emphasized in the statistical or biometrical investigations of Karl Pearson, and that this type connotes extreme sexuality is borne out by the observations of Pierre Marie and his co-workers at the Salpêtrière. Crookshank maintains that "the Bengalee is pretty much in the same state as a sufferer from a *forma frusta* of exophthalmic goitre; while the pigmentation and genital gigantism of the negro are suggestive of adrenal assertion." He further points out that "certain genital malformations or abnormities are almost always accompanied by adrenal tumors; and Iscovesco has shown that adrenal lipoids when administered hypodermically rapidly produce genital overgrowth."[36] On very slender evidence, achondroplasia has been correlated by some observers with disease of the pineal body (epiphysis cerebri), which Descartes regarded as the seat of the soul. Disease of the pineal in young children sometimes results in increased development of the sexual organs with corresponding growth and mental precocity, whence it is inferred that the pineal secretion inhibits growth, particularly the development of the reproductive glands.

Of the internal secretions of the pancreas and the sexual glands, the thyroid, parathyroid, suprarenal and pituitary bodies, considerable is known; less of the spleen, carotid gland and pineal body (epiphysis cerebri); of the "parathymoid" and the paraphysis of the brain, nothing whatever. The vast amount of recent investigation on the subject has been well summed up in the treatises of Sajous (1903), Arthur Biedl (1910), Swale Vincent (1912) and Wilhelm Falta (1913) on the internal secretions, and such individual monographs as those of Friedleben on the thymus (1858), von Eiselsberg on the thyroid (1901) and Cushing on the pituitary (191–). All these are liberally provided with bibliographies, Cushing's book being a model in this respect, and Cushing and Falta give splendid illustrations. Cushing's work, which a competent critic has pronounced to be the most important American monograph on a surgical subject printed in the last ten years, is also a genuine contribution to internal medicine. With John Hunter the surgeon began to be, not only an experimental physiologist and pathologist, but also a clinical observer. Modern medicine affords many examples of original descriptions of new diseases by surgeons, in particular, Sir James Paget and Sir Jonathan Hutchinson, whose "Archives of Surgery," twelve volumes entirely written by himself, is a great storehouse of unique pathological observations. Professor Cushing's work is in this class, the subject is approached from the physiological, pathological, clinical, surgical and ophthalmological sides, and in its combination of induction from experiment with the Hippocratic induction from experience, it is a fine exemplar of what Sir Michael

[36] Crookshank, "School Hygiene," London, 1914, V., 71–72.

Foster regarded as the ideal method of investigation in internal medicine:[37]

Each case of illness is to the doctor in charge a scientific problem to be solved by scientific methods; this is seen more and more clearly, and acknowledged more and more distinctly year by year. Nor is it true that each science has to a certain extent its own methods, to be learnt only in that science itself; and from time to time we may see how a man eminent in one branch of science goes astray when he puts forward solutions of problems in another branch, to the special methods of which he is a stranger. In nothing is this more true than in an applied science like that of medicine. At the bedside only can the methods of clinical inquiry be really learnt; it is only here that a student can gain that kind of mind which leads him straight to the heart of disease, that *genius artis,* without which scientific knowledge, however varied, however accurate, becomes nothing more than a useless burden or a dangerous snare. Yet it is no less true that the mind which has been already sharpened by the methods of one science takes a keener edge, and that more quickly, when it is put on the whetstone of another science, than does a mind which knows nothing of that science. And, more than once, inquiry in one science has been quickened by the inroad of a mind coming fresh from the methods of a quite different science. For all sciences are cognate, their methods though different are allied, and certain attitudes of mind are common to them all. In respect to nothing is this more true than in respect to the methods of medicine. Our profession has been the mother of most of the sciences, and her children are ever coming back to help her. In our art, all the sciences seem to converge—physical, chemical, biological methods join hands to form the complete clinical method.

[37] Foster, Huxley Lecture, *Nature,* London, 1896, LIV., 580.

THE ETHICAL PRINCIPLE IN PHYSICAL VALUATION FOR RATE MAKING

By E. W. JAMES

OFFICE OF PUBLIC ROADS, U. S. DEPARTMENT OF AGRICULTURE

THE history of the control of public service corporations in this country is very short, but its interest is great enough to warrant even now a historical monograph of considerable length. Though the movement toward governmental control is new, it has been rapid. It culminated about a year ago in the passage of a law authorizing the Interstate Commerce Commission to make a valuation of railroads under its jurisdiction. Physical valuations have been provided for in Wisconsin, Nebraska, Washington, Massachusetts and other states. In general, the state valuation laws, as, for instance, that in Nebraska, provide for the valuation of practically all public service corporations. When we consider the history of corporations in the United States, the adoption of this policy with a view to control of public utilities appears logical enough, and opens a new field of discussion. Some parts of our railroads are eighty years old. Many were built under unusual conditions. The early days of many public service corporations display a tangle of promotion, corruption, lease, combination, purchase and reorganization. Original records in many cases are lost. As a result, the discussion of physical valuation has been largely confined to consideration of the ultimate, technical details of some practicable method, to the neglect of important underlying principles. Valuation has been usually argued from the point of view of the material interests of the disputants. It has been only within the past two or three years that really serious conclusions have been arrived at; and the discussion since the passage of the Physical Valuation Act affecting the Interstate Commerce Commission has alone provided some basis for a formulated set of principles around which interest now centers. A small vocabulary of technical terms has developed in the course of the debate as to principles and methods.

There is an aspect of valuation that has not received the emphasis it deserves. A study of the economic and social phases of the subject may be made much more illuminating than it has been. It appears that such a study would provide a solvent for several of the problems now in dispute among writers of undoubted ability and experience. In the first place, the public attention has not been directed toward corporation control because it had nothing else to busy itself with. The movement toward physical valuation is not an erratic one. The public's point of

view has of late years been changing. People are seeing that they have an interest in public service corporations different from that concerned merely with securing good gas, steady current, accommodating trolley service, or pure water. The new laws providing for physical valuation as a basis for determining rates for the use of public utility products or services are an evidence of this change of attitude.

That the public, the user, has been slow to recognize his real interest in public service corporations does not in the least lessen the rightfulness of that interest, or its substantial basis in fact. A savage has little or no ethical life; for although an ethical principle may be absolute *per se,* the strength of that principle applied depends on contributory circumstances of a nature to compel its recognition. Circumstances of corporation growth, the misuse of the power flowing from privileges granted to individuals by public official bodies, have at last forced the user of the public utilities to recognize his ethical right to consideration.

The interest of the user in the public service company is, of course, first of all, material. The company furnishes some service necessary to health or to the reasonable comforts of modern life, or something necessary to business. These services can not generally be secured except from the public service corporation. For this reason the corporation is looked upon rightly enough as a quasi-public organization. It is no longer a private affair. It is not like the corner grocer or apothecary, who has a competitor on the next corner to whom the customers can go. It is not like the butcher, who has his stall in the public market in a row of twenty similar stalls, and who competes for trade among the passing throng. The public service corporation has, in great degree, the character of a monopoly. The quasi-public element in the public service corporation is recognized originally and conclusively by the grant of any franchise carrying special privileges or providing for exclusion of other similar corporations.

In addition to this material interest, arising in the need of the community for fresh and pure water, light, heat and transportation, there is the other, deeper consideration spoken of above. This flows from the material interest, and is best described as an ethical interest. It is not merely by equity or expediency that the user has rights in public service utilities. It is because he puts something into the business. What he puts in is fixed capital; he can not withdraw it, and heretofore has had little or nothing to say regarding the management of his share of the investment. Much of this fixed capital, owned by the user of the public service utilities, is in the form of franchise privileges granted by the user, through his representatives in the local legislative body, for a period of years or in perpetuity. It is just as surely a vested interest as the money of the bond holder which has laid rails or strung wires, dug ditches or erected pumping stations and gasometers. The fact that the

consumer turns the management of his interest in the business over to the other party, together with the fact that when once these contributions are made they can not practicably be withdrawn, establishes the right of the user to fair treatment at the hands of the public utility company. Still stronger appears the user's right to fair treatment when it is considered that he is, in the very nature of the case, the residual investor. That is, under any plan to establish such rates as will provide a "fair return" to the money investor, the user must hold himself ready at any time to meet all demands for financial support involved in the operations of the utility. The user may not provide additional money capital in the early years of development, and may never indeed do so. But if such becomes necessary, the user must, as will be seen, assume the burden of interest charges created by the required borrowing. Mutual obligations between the user and the producer follow naturally as a result of mutual interests. These obligations are as binding on one as on the other. Responsibility for fair treatment has in the past rested with the producer exclusively, because he has occupied the position of control. Unfortunately, the user has not been convinced by the treatment that he has received that his rights have had the recognition they are entitled to. The present movement has resulted, and the relative obligations of both parties are now very generally understood. The investor and producer must be secured in an adequate, "fair return" on his investment. The investment does not necessarily include all the money spent in creating the utility. It is no part of the user's duty to secure to the investor a return on funds spent unwisely, unnecessarily or in any improper way. For instance, construction work might have been done and paid for at an exorbitant rate. It later might develop that the officials in charge of construction were materially interested in the contract and had paid for work at unwarrantable prices because it was to their own advantage to do so. This is the simplest case. More involved ones have not infrequently occurred having essentially the same result. Such expenditures are not wise or necessary by any means, and the user is not bound to recognize them as a part of the investment on which the producer is entitled to a "fair return."

The chief right of the user is to receive efficient service at a rate as low as possible consistent with the right of the investor to receive his "fair return." It is the obligation of the producer to see that this service is provided at a "fair rate" consistent with the conditions under which the public utility is expected to operate. It is the consciousness of these mutual obligations that is the basis of laws restraining public service corporations. The user has seen his investment exploited for the benefit, not of himself, but of the producer. The capitalization of anticipated profits, stock dividends, unduly large underwriting fees in effecting combinations, common "watering" of stock, manipulating and

speculating in the securities of public service companies, have all operated in most cases to the disadvantage of the user, the co-investor in the concern. Legal relief has been the obvious remedy sought, and if it has seemed arbitrary, such a condition is only natural as a kind of reaction against the formerly very loose check set upon the conduct of the producer.

It is generally agreed now that a common ground of adjustment has been reached, and that by making a physical valuation of the property of the producer, it will be possible to fix the "fair rate" that is consistent with a "fair return" to the producer under the conditions of operation required of the public utility under consideration.

The details of physical valuation are involved and numerous. Much discussion has taken place, and it continues from week to week in the press and in the courts. Very excellent authorities are at difference with each other on essential points. The difficulty appears to reside in the fact that a common basis in principle cognizant of the interests of the public and of the producer can not be found by those attempting to establish the methods of physical valuation. The first point that must be understood is that a public utility property shall no longer be speculative in character. This is the obvious result of the recognized obligation on the part of the public—the user—to assure the producer a "fair return" on his investment.

The returns on the public service utility investment are, under the plan proposed, to be made fair and equitable by establishing such a rate for the service that the "fair return" will be reasonably assured. This removes the utilities stock from the speculative class. Further, if there remains a speculative element in the utilities stock, it would be an indication of necessary readjustment of "fair rates" to "fair returns."

We are now ready to consider some large details of a physical valuation which are illumined by the principle outlined above; namely, that the user has a right in the properties of the public service utilities; that this right rests on the investment of certain valuable contributions necessary to the operation of the utilities; that flowing from these rights is an obligation that the investor shall be assured a "fair return" on his investment.

If records were complete, the ideal method of arriving at the investment of the investor of funds would be at hand. In some cases it will doubtless be found that such records are complete. Where they are not, the obvious course is to reproduce the actual conditions under which construction was advanced, and estimate the original cost of the properties. There is little difference of opinion that cost of surveys, preliminary studies and investigations, and underwriting and promotion charges which are wise, necessary and reasonable, should be allowed. What shall determine reasonableness in this case is open to debate, but we have

some checks. We know that the ordinary commission on stock transactions is one eighth of one per cent. Six per cent. is considered a fair return on investments free from unusual risk. Here, then, are upper and lower limits that may be considered reasonable for underwriting and promoting. The excessive commissions occasionally taken in promoting industrials are certainly unwarranted and should no longer be allowed. In valuating past performances of this kind, and allowing for due risks in the original scheme, it is doubtful if a greater promotion charge should be recognized than would be just and fair to-day. The fairness of this will further appear when we consider deficits and their place in valuation for rate-making purposes.

There is little or no dispute over the valuation of large single elements of the properties until we come to land. Here we meet the first troublesome detail of the subject. The question of land values has puzzled almost every commission to whom has been assigned the physical valuation of utilities. The chief point in dispute is the place of unearned increment. There is no doubt that the actual cost to the company of the land that had to be taken should be allowed. If the cost is a matter of record, it should be taken. This cost should include the necessary severance, damage, transfer and legal charges connected with taking the land. In most cases the records do not exist, and an approximation is resorted to involving the use of a factor to be applied to the present market price of adjacent land. In any case, however, the principle to be followed prescribes that the actual net cost of acquiring the land at the time it was purchased shall be approximated as nearly as may be. To this nothing should be added to represent the increased value since acquisition. This statement is most vigorously combatted by some, but its justice and fairness will, I believe, be made apparent.

The principal argument to support the inclusion of the unearned increment is that the public service corporation should not be denied advantages that flow to all the surrounding land holders. If a valuation were being made for sale, taxation or rental purposes, the inclusion of the increment would be right. But a valuation for rate making should not include it. In the first place, it is only a potential value. A homesteader can not live on his land, develop and use it, and at the same time realize a return on its unearned increment. He has to sell or rent to secure the advantage of it. If a utilities corporation chooses to rent or sell, it doubtless is entitled to take advantage of the unearned increment, if it can find a purchaser on such terms. Further, the unearned increment of the land does not represent an investment of the producer but of the user. The increment arises from the development of the land contributory to the railroad. It is greatest in sections where the development is greatest. It is in essence a contribution of the community. The community is nothing more nor less than the user in an aggregated

form, and, as we have seen, the user is a co-investor with the producer in public utility properties. Obviously no part of the return on the user's investment should be included in a "fair return" to the producer. It follows, of course, that lands donated, whether by a person, by a commercial body, or by a government, should not appear in the valuation at all.[1]

An objection might be raised in the case of a utility comprising several smaller properties obtained by purchase. It is probable that the existing corporation paid prices for the land involved that were determined by the current prices of adjacent land at the time of purchase. These included the unearned increment to date. This increment should not be included in the valuation of the combined properties for rate-making purposes. If the purchasing investors were willing to agree upon a price including any part of the unearned increment to date of purchase, they were in the place of a man who, to secure a valuable property of forty acres, buys up four ten-acre places. So long as the purchaser uses the forty-acre place himself he gets no return on the unearned increment, except that flowing from increased enjoyment, a better outlook, or more freedom of action. He recovers that portion of the purchase price invested in unearned increment, with or without interest, when he sells. If he never sells, he never recovers it; and moreover, he loses interest on the investment. If a corporation makes such terms, the users can not fairly be required to pay a return to investors on values contributed by the community. The profits of the investors reside in the continuing increment, if such there be; and they can be taken only at the time of sale. It may be that the whole transaction, involving the purchase, holding and sale, does not show a profit. This may frequently occur; but it is no reason why the public—the user—should be compelled to assume the responsibility of guaranteeing such profits. Some transactions are bound to show loss.

One very remarkable contention has been made in connection with the valuation of land. Stated in its simplest terms, it is this: If a utility has secured the land necessary for its activities, this land should be given a value determined by the advantage residing in it above that afforded by the next less desirable land usable for the operations desired. For instance, if a railroad has located in a very desirable pass, the value of the land in the pass should be determined by the saving in expense both in construction and operation over the next possible location in that vicinity. This argument needs no further attention.

Let us now apply this principle of user's investment to the question of depreciation. This is the next important ground of dissention among

[1] Similarly, bonds guaranteed by counties, a procedure not at all uncommon in the southern states in railroad promotion, have no place in a valuation for rate-making purposes.

writers on the subject of valuation for rate making. It is sometimes held that depreciation should be deducted from the original cost as reproduced. Whether valuation, up to the point of considering depreciation, has been according to the method of cost-new or not, it is quite clear from a statement of the principle of user's interest that depreciation should not be deducted. If an assumed case is considered, this will be seen at once. Suppose a public utility has been paying all obligations, meeting all charges for operation, repair and maintenance, providing annual allotments to such amortizing funds as may be practicable, and making a "fair return," and no more, to the investors, at any rate whatever to the user. Providing there has been no accumulation of surplus, the utility has been doing no better than should be expected of it. Suppose now that owing to any cause at all, maintenance can not be such that depreciation is checked or offset. Or suppose that elements—really a large part of many properties—that can not be practicably amortized by annual allocations, require replacement. If no surplus has accumulated and no more than a "fair return" has been made to investors, it is apparent at once that the rate to the user has been too low. The user has not been contributing, in his innumerable, continuous, small payments, an adequate part of the cost of operations. We have seen that the user is the residual investor. Indeed, this fact makes his ethical right to consideration particularly strong. The "fair rate" that he must pay is not fixed, but the "fair return" to the producer is first assured, and the user is then called upon to contribute what is required to operate the property. If the user is not compelled to pay a rate sufficient to provide for depreciation and consequent replacements, the funds must be secured elsewhere, and this means that new investors come in to whom there must be paid a fair return on a sum equal exactly to the depreciation.

Before leaving this question of depreciation, it might be well to treat it from an entirely different point of view, in order to establish undoubtedly the fact that it must be met by the user. Dr. L. I. Hewes, chief of economics and maintenance, of the United States Office of Public Roads, has introduced the term "absolute maintenance" in connection with the upkeep of highways. As an annual matter, it is only an accounting term. It can not, in most cases, be practically applied each year, for it means maintaining the road in its originally improved condition without deterioration. It includes the charges for resurfacing that occur at the end of a period of years. These charges are distributed equally over the years since construction or last resurfacing, and, together with the annual charges for ordinary repair and maintenance, constitute the annual absolute maintenance charges. There can be no depreciation charged off against the property if an absolute maintenance charge is made.

The conditions under which public service utilities operate demand that they be absolutely maintained.[2] Obviously, it is from gross receipts that all maintenance charges must come. It is financially unsound to use investment funds merely to maintain, and if the user is rightly expected to pay a rate that will, after meeting the "fair return," straight operating expenses, interest, taxes, etc., provide a balance sufficient absolutely to maintain the property, that means that there can occur no depreciation to be deducted, and if annual maintenance charges are less than absolute, and depreciation occurs, it is not to be deducted, because the user has contributed less each year than he rightly should. He has been postponing a part of his payment.

If the depreciation is not taken care of by the user, then the producer may relinquish a part of his "fair return" in order to provide for replacement, and we find our depreciation producing a deficit. We are now ready to consider another controverted matter, called sometimes the deficit theory.

This problem can be attacked in exactly the same manner as depreciation, keeping always in mind our ethical principle, which involves the user jointly with the producer as parties having material interests and mutual obligations in the conduct of public service utilities. In establishing the justice of the deficit theory, the fact previously stated, that the user is the "residual investor," is of greatest force. If business under the usual conditions of developing enterprises is insufficient to meet all operating charges, pay interest, taxes and insurance and furnish a "fair return" to the investor, under practical conditions existent, a deficit is the result. As rates could not, as a practicable measure—and can not, even under the system projected—be adjusted during the development period so as always to produce sufficient gross revenues to meet all demands, the user can not, from his own contributions, provide the necessary further funds. His managers—the producers—either advance the funds for him, or, in other words, forego a part or all of their "fair return," or secure such advances from outsiders. In either case, the user must assume the interest charges. It is not desirable that funds be secured from outside sources if the accumulated "fair returns" are in themselves sufficient to meet the demand, so generally such sums are foregone by the producers as are necessary to meet all charges, and true deficits are incurred. The user, as we have seen, must assume the interest charges on additional funds, if such are secured from outside. Similarly, he must assume the interest charges in the shape of a "fair return" on the deficits covered by the producer. The plain way to ac-

[2] This does not consider that some utilities work at full efficiency after about 25 per cent. depreciation due to "normal wear," but the argument is not affected, as absolute maintenance must follow from the point at which permissible depreciation stops.

complish this end is to include in the valuation for rate making the accumulated deficits to date.

We must not stop at this point, however, in our discussion of deficits. The principle we are applying stands for fairness above all things; it is ethical in nature, recognizes rights and obligations which are mutual. If a public service corporation has in the past paid huge dividends, made distributions of stock, and then continued to pay dividends on these paper values; or if future profits, speculative values, have been capitalized and a return made on this capitalization, we are in the opposite position from that involved in the accumulation of past deficits. Early deficits incurred in the development period may long ago have been wiped out. Perhaps surplus funds have accumulated and extensions been made to the original property. In this case, the situation is just as clear as in the former. The returns over and above accumulated past deficits plus a "fair return" should be deducted from the cost-new. In this case the producer has taken more than his "fair return" in the past; the user has contributed more than his "fair rate." An adjustment could be made by having the producer disgorge, but this is not practicable, and the simple and obvious procedure is to permit the producer to retain what he has received, which assumably bears him interest, and deduct it from that capital sum on which the user is to provide a "fair return" in the future.

We are now in a position to discuss surplus, and it will afford another basis of attack on the problem recited just above. Surplus is more easy of definition than most of the elements we have been dealing with. It is the remainder of gross receipts after operating charges, including taxes and insurance, absolute maintenance charges, interest charges, and a "fair return" to investors, have been met. If it exists, it can belong to but one party—the user. The producer should have no benefit from it. The user is the residual investor, the "fair rate" is the dependent function, the user is called upon to make good depreciation, deficits, and to provide a "fair return." But if a surplus is accumulated, the user at last finds something that returns to him. Either the "fair rate" is subject to adjustment, or else the user can accept—and usually would do so under practical conditions—extensions and improvements in the utility. These added values should produce no increased returns to the producer.

If now we apply these principles to the conditions supposed above, involving past unduly large returns to producers, we find that had the parties concerned—the user and the producer—recognized their mutual rights and obligations, and, in consequence, had none but "fair return" been paid to the producer, there would have resulted a large accumulated surplus. As we have seen, this belongs to the user, and if the producer has appropriated it, he should return it, or the user should be relieved

of his obligation to the producer by an equal amount. Thus is our previous conclusion supported.

In the course of this discussion, the expressions "fair rate" and "fair return" have been repeatedly used. These terms need no explanation for the ordinary reader of the subject, but the ethical principle applied throughout this paper has its effect in establishing the character of a "fair return," and to this we may now apply ourselves.

We have seen that the user is the residual investor, he appears to get the small end, he has no personal voice in the management of his part of the utility properties. These circumstances are directly attendant on the nature of the contributions made by the user. These are in large part community values that have cost the user nothing directly in money, or else they are made in small amounts from time to time, and at least a portion of such small, continuous and numerous contributions go to purchase some immediate return. This position as residual investor means that the "fair rate" to the user is adjusted, with many attending conditions, to provide a "fair return." The community undertakes to guarantee, in some measure, the safety of the producer's investment. This party is protected against depreciation or deficit, and always against the effects of competition. The regulations under which the mutual arrangements exist have a legal status—are a part of the law of the land. Here, then, we have a condition free from large risks. In the development period, returns may be delayed; but the producer is assured that he will not lose, that all such withholdings will be made up to him and become a basis of continual "fair return." This statement of the case at once disposes of the contention that a "fair return" should be above ordinary interest rates. In fact, the beam is depressed on the side of a lower return than customary in private transactions. Certainly a "fair return" should never be greater than that expected from a permanent or long term investment in a property free from unusual risks.

Finally, we are ready to discuss profits. Many writers hold that in addition to a reasonable interest on the fund invested, the fair return should include profits. The unusual foresight of promoters, the great ability of managers, the doubts and dangers of loss in early days, are all recited as reasons why profits should be allowed. But, sticking strictly to our last, and recognizing the principle here stated in connection with valuation for rate making, we find that the foresight of the promoters has been paid for in proper underwriting and promoting charges, the doubts and dangers of loss have been removed when the user assumes the responsibility of providing for absolute maintenance, and the ability of the managing officials has been rewarded in the usual manner and met as a part of operating charges. The producer, in his personified aggregate, is, to be sure, fewer in number than the user in his personified aggregate. But, nevertheless, the producer is not a personality, and

nothing is due him for promoting, managing or by way of compensation for hazarding loss.

Further, profits are the basis of speculative activities, and the one thing that must be recognized above all others, and without which no valuation can be made justly or equitably, is that public utilities are not speculative in character. If they become so at any time, the speculative element must be excised ruthlessly and surely.

A point around which much discussion hangs is the character and place of "going concern value." Once we have taken care of absolute maintenance and the deficit theory, together with the accompanying details of surplus and profit, there is nothing left of "going concern." It is an inclusive term to cover matters not fully grasped in the early days of the valuation discussion, and should have no place to-day.

In conclusion, we must admit that in applying any principle to the adjustment of human affairs, the personal element must be recognized. There is always the matter of wise and unwise payments in the construction period; the personal honesty of officials especially during the period of development. What are we to do with the case of a trolley concern that builds to develop a subdivision? If, through greatly facilitated communication, the subdivision prospers, if the promoters of the real estate transaction and of the trolley company are one, if also the real estate deal produces big profits, but the trolley runs at a deficit, what is to be done? It is useless to deny that complications of the most puzzling kind will be found in arriving at valuations for any purpose. Questions innumerable will arise involving equity, the early history and conduct of absorbed utilities, subsidiary companies, and a complexity of others. But if a few basic principles can be established and adhered to; if the courts can be prevented from piling up a mass of conflicting, baseless precedents that will become millstones about the neck of the appraiser; if skilled appraisers are sought; and if the great, the tremendous importance of these valuations and their profound influence on social and economic conditions are recognized, there is a hopeful future for public service utilities, their producers and their users.

THOUGHT IN SCIENCE AND IN SCIENCE-TEACHING

By Dr. BENJAMIN C. GRUENBERG

JULIA RICHMOND HIGH SCHOOLS, NEW YORK

FOR the sciences as taught in the secondary schools in all parts of the country, there is generally claimed a "training" value in addition to the informational value. In common with the teachers of the so-called "humanities," many of the teachers of the natural sciences claim for their subjects the power to develop in the student certain intellectual and moral qualities. These highly desirable results are reputed to flow from the "mental discipline" involved in the effort to overcome difficulties, in the exact and orderly sequence of the intellectual material, and in the method of the laboratory.

Many psychologists deny outright the claim of any subject to have a disciplinary value. This denial is based deductively on certain modern generalizations as to the workings of the mind, or the break-down of the "faculty" hypothesis; it is based inductively on the results of certain experiments made in recent times, upon the effects of various learning processes. It is the purpose of these notes to base the denial of the general claim upon the results of observations on the mental processes of certain persons who may be presumed to have acquired the full benefits of whatever training the study of science is able to impart, namely, teachers of science. In addition, I wish to point out the direction in which I think it is worth while to look for "educational" results, as distinct from informational results.

Do teachers of science in general exhibit those special virtues which science learning is supposed to cultivate, in a degree above that shown by the average citizen? Or by the teachers of other subjects?

In the matter of *observation,* the teachers of science with whom I have come in contact are not more *comprehensive* than the teachers of history or of languages. The only criterion I have of this is "what kinds of phenomena are noted?" The science teachers are not more catholic in their interests or in their range of observations. On the contrary, I have found many teachers of history and of language who take an intelligent interest in the development of science, as well as in the phenomena that fall within their own specialties; but I know comparatively few teachers of science who take an intelligent interest in matters foreign to their specialties. And their observations, as gaged by their comments and conversation, are as restricted within their respective fields as are their interests beyond. If we consider the *accuracy* of the observations in their own fields, it remains an open

question whether this accuracy is not itself a contributing factor in the selection of their specialties, rather than a result of pursuing the studies. But in so far as the ability to make minute observations on special material is the result of training, it may mean simply the acquisition of a special technique for running a fine-tooth comb over particular classes of objects, and not a general habit of taking in details at a glance. Teachers of physics are not especially acute in noting variations in the leaves of plants that they happen to pass; teachers of biology are not especially keen in observing delicate changes in the facial muscles; teachers of chemistry are not exceptionally alert in discovering the new fashionable angle for the cut of reveres. Whatever excellence of observation any of these may show seems to be confined either to the subject-matter or to the material in which the individual has a special interest. But this is just as true of mathematics teachers and of milliners, who never studied any "science" at all.

The method of science or of the science laboratory is supposed to develop a certain "instinct" for *system* or *order*. My observations do not support the expectation that science teachers are exceptionally orderly in their handling of materials. A working scientist must certainly have some sort of system in his head, but scientific work of a very high grade seems to be quite compatible with personal habits of a very high degree of disorderliness. Science teachers can not guarantee to the fond parents that the science courses will make the children any more careful about hanging up their hats and putting away the books than they were before. It is not to be denied that many individuals received from some well-conducted laboratory their first inspiration to make a place for everything and to keep everything in its place; but it is equally true that a successful science teacher may reside in the same skin as that occupied by a person who only occasionally gets his personal belongings into the right place—at home. At any rate, the science teachers that I happen to know are not as a class more systematic in their handling of materials than are the teachers of other subjects, or than the business men and housekeepers who never studied science at all.

When we extend this principle of order to the matter of time, we find the same failure to generalize the training. Teachers of science within my experience are not more punctual in keeping engagements; they are not more prompt in setting to work when it is time to set to work, or in stopping when it is time to stop; they are not more systematic in planning the work of an hour or of a day. The individual variations seem to be as great among science teachers as among shoppers, and their general efficiency with respect to planning their time to the best advantage is exceeded by many housekeepers and clerks who lay no claim to special training.

When it comes to having system or order in the handling of ideas

that are not parts of the routine work, I have found that science teachers are as easily bewildered and disconcerted by unfamiliar concepts as teachers of mathematics, and much more easily than teachers of history. This may mean that I happen to be acquainted with exceptionally clever teachers of history or with exceptionally stupid teachers of sciences; but it would not be fair to assume this. The general intelligence of the many teachers I have in mind (as this may be judged from casual intercourse in school, in committees, in general contact outside) does not show a correlation to the subjects taught.

The fact seems to be simply that the teacher of science is just as likely to become petrified under suitable conditions as the teacher of any other subject. So far as science teaching has gone in the past, it has not yet established a universally acting dynamic principle in the character or the mind of the student. Not only are new ideas met with hostility, but when he is forced to handle them the science teacher does not show that system in his attack which his training has putatively imparted. If he does show order in analyzing a problem in his own field, this may mean only that he has learned a useful formula for attacking certain types of problems. The value of the "training" should show itself when problems of new types are met.

This leads to the next virtue which science is expected to develop, namely, the *judgment*. We no doubt learn to judge by judging; but I have not found science teachers, in dealing with matters outside their specialties, exhibiting greater deliberation, broader vision or less prejudice than are shown by just ordinary people of "culture." On the contrary, the most complacent and immovable spirits I know are among teachers of science.

It is impossible, from the data at hand, to come to any final conclusion as to the causes of this apparent incompatibility between the results of science teaching, as shown by the teachers, and the possibilities of science teaching as claimed by these same teachers. But some of the causes are near the surface and are worth noting.

The concept *science* is not itself sufficiently definite, judging from the senses in which the word is used. Thus, one science teacher speaks of another as being "too scientific" in his teaching because the latter employs many technical terms in the class room. Technical terminology is here confused with "science"; and any person of common sense can tell you that it is not at all *scientific* to use in teaching such terms as make the work of the pupil unnecessarily difficult. Another teacher prides himself that he has a thorough scientific training, since he is able at a moment's notice to describe the laboratory technique for any experiment or demonstration you are likely to want; and his familiarity with this technique is the result of long and intensive laboratory experience. But we forget that a laboratory helper can acquire all these details

without understanding either their pedagogical purpose or their theoretical significance. One science teacher speaks of another as being "well up" in science, because he knows the names of minerals or of spiders that you and I never heard of; or he knows all the stages in the life-history of some very rare red sea-weed. Here science is confused with erudition that happens to concern itself with objects of nature rather than with words out of books; but erudition is not science in the one case any more than in the other.

Another defect in much of our current science teaching lies in the fact that the method of the *experiment,* which is supposed to be one of the fundamentals in modern science, is often taught as a matter of manipulation rather than as a matter of thought. Thus, in presenting certain types of experiments, the negative instance or control is entirely ignored. A chemical test is given, let us say, for the identification of starch, or for determining its presence. The teacher shows that the addition of iodine solution to starch produces a blue color; the application is immediately made by placing some iodine on bread: the conclusion forced out of the minds of the unsuspecting victims is that bread contains starch! I quote from an elementary biology by well-known teachers:

1. Put a small amount (size of pinehead) of corn starch in a test tube, add water, shake the mixture, and boil it over a gas flame. Pour into the starch mixture thus formed a few drops of iodine. What color is produced?

2. Try the effect of iodine on each of the other food substances as follows: Put a small amount of grape sugar into a test tube; into a second tube put some white of egg (protein); into a third some fat or oil; into a fourth some mineral matter (salt); and into a fifth some water. Add a little water to each and boil as in 1 above to cook each nutrient. Add a drop or two of iodine solution to each tube.

Do any of the colors thus produced resemble at all the color resulting from the addition of iodine to starch?

3. From the preceding, state how you can determine whether or not a substance contains starch.

Or we are to show that water is essential to the germination of seeds; and we are content to rest the case on the fact that seeds supplied with water did under certain—but undefined—conditions actually germinate; or we may accept the conclusion on the fact that seeds without water did *not* germinate—overlooking the equally obvious fact that certain seeds without soap-powder or star-dust also failed to germinate.

One biology teacher, after drilling the simple chemical tests for the nutrients, proceeded to apply the acquired knowledge in true pedagogical fashion, by testing an "unknown." The unknown proved to contain both starch and proteins. The *application* came when the teacher asked, "Well, then, is this substance fit to eat?" An affirmative answer was promptly forthcoming, and there ended *that* lesson. In an

extensively used text-book of zoology, written by a biologist of international reputation, occurs this passage:

An excised representative sample of hydra will reproduce the whole: but you can not perform this experiment with the frog.

To one who looks upon an experiment as a means of testing hypotheses there is no obvious reason why "this experiment" can not be performed with a frog, or any other beast. But if the experiment is a means for getting certain desired objective results, of course it is impossible to get a complete frog to regenerate from an "excised representative sample"—as we know from experiments!

That the experiment does not always mean to the teacher the same as it does to the investigator may be inferred from the fact that many teachers are not averse to "faking" experiments that are arranged for demonstration purposes. William James tells in one of his papers of his own performance in a physiological demonstration, and he justifies it upon pragmatic grounds. The question I am raising is not one of ethics, but of clear thinking. If the experiment is a didactic tool for presenting concrete, objective processes, it falls into the same category as wall-charts and models. The demonstration experiment need not then be any more "real" than a glass model of the eye or of a diamond. But if the experiment is used by the teacher for the purpose of teaching method in thought or in the solution of problems, the "unsuccessful" experiment should be at least as illuminating and educating as the "successful" one.

A third source of confusion lies in the apparently harmless little word "law." A student of science should certainly know what is meant by a "law of nature"—but we may not expect him to if his teacher does not. Now it is altogether too common to hear teachers of science speak of the laws of nature in exactly the same way as ordinary folks whose notion of "law" is derived from the statutes of the commonwealth or the commandments of the gods. In science a law is presumably a generalization from a limited series of experiential data, not a prohibitive or mandatory order from some superior authority. Our attitude toward Boyle's law, for example, is in no way related to our loyalty to Mr. Boyle. In ordinary usage there may be violations of "law" and such violations are frequently followed by disagreeable consequences. But in "nature" the consequence is not something superimposed by way of punishment or retribution; it is itself a part of the law, and integral in the general process formulated in the law. Laws of nature can not be violated in the sense that statutory laws can be. Laws of health are descriptive generalizations of the conditions under which normal health is maintained. Yet we speak of empirical rules for securing these conditions as also being "laws of health." In practise we may or we may not observe these rules; but we can not *violate the laws.* Morbid conditions also arise in conformity to law. There is

nothing unlawful or lawless in a curved spine or chronic constipation or an accidental poisoning. It is inconceivable that the ordinary pupil will get any very clear idea of "law in nature" from teaching that is as ambiguous as that of most teachers in the matter of *law*.

Ambiguous and misleading use of significant terms shows itself further in connection with ideas of *causation*—which certainly ought to be fundamental in science teaching. A teacher asks the question, "Why is air necessary to a plant?" Now this is a perfectly legitimate question if the meaning is "What is the relation of air to the maintenance of life in a plant?" But I have heard this and similar questions asked when the teachers' meaning was substantially, "What is the evidence that air is necessary, etc.?" In about three fourths of the cases the pupils will answer such a question by saying "Because the plant can not live without it." Teachers will frequently in such cases *teach another answer*—presumably the "right" one—but there will be no clearing up of thought.

Another type of question confuses a vague teleology with physiological principles of function, or with some ecological theory of adaptation. Thus, "Why has the grasshopper longer hind legs than the walking stick? Why has the rose-bush thorns? Why has a fly a shorter proboscis than the butterfly? Why has the bean-blossom a showier corolla than the oak?" These are actual examples of questions asked by teachers of biology in various schools. Strictly speaking, such a question means, "How came this organism to have the character in question—organism here standing for species?" Which no one can answer. The pupil may have read or have heard of the speculations of Darwin or of Lamarck, but if he has, he should have been informed also that they were speculations. I have heard teachers who are regarded as of high merit asking such questions when they meant simply "What is the advantage such an animal has from this character?" Not only is the apparent utility, function or adaptation tacitly assumed by many teachers to *explain* the existence of organs or instinct, but the adaptation itself is assumed to be the "intention" or purpose of nature. The expression "nature's intention" is frequently heard in the class room. It may be impossible to speak in our public schools of the "purpose of God" without prejudice; but it does not seem to be a bit more scientific—and it is much more presumptuous—to speak of the "intention of Nature."

In the matter of intellectual honesty, does the teacher of science show any superiority over other teachers? The science teachers do not appear to me to be less prone than other teachers of my acquaintance to resort to indirect methods of accomplishing practical results. They do not appear to me to be less evasive in their dealings with subordinates or superiors. Pupils are constantly impelled to ask questions suggested

by details in the lesson. Many of the questions are unanswerable in the form given, or in the present stage of our knowledge, or in the present state of the teacher's knowledge. How many teachers say frankly and unequivocally "I don't know"? I have failed to observe that science teachers are less given to that pedantic way of saying "I don't know" which the unsophisticated can not always interpret to mean just that. Here are a few of the questions that I have heard pupils ask of their science teachers without getting a direct answer, or the information that the teacher could not supply the answer, or a reference to some other source of information: Why does magnetism act only on certain kinds of metals? What makes roots and shoots respond to gravity in opposite senses? Why does not a grape-seed germinate inside the grape, where there is plenty of water? Why do sodium and potassium produce different colored flames? Any one can extend the list indefinitely. Many teachers have a favorite way of deferring these troublesome questions to "the next time" in the hope of gaining time for informing themselves—let us hope; or in the expectation that the question will be lost in the shuffle before next time. But the children are either clever enough to see through the trick, or unconsciously absorb the method of indirection to reenforce the lessons they have already learned from the iceman and the grocer.

Where science teachers come in contact with administrative activities, I have found them just as ready to accept the conventional evasions of the strict letter of the law for the purpose of achieving desired ends, as other teachers. And, on the other hand, I have found them just as ready to resort to the strict letter of the law for the purpose of evading the responsibility of making decisions or of taking initiative, as teachers of other subjects.

Teachers of biology—a subject that is supposed to be particularly saturated with the concepts of evolution, which postulate the principle of *constant change*—are among the most reactionary of my acquaintances. I know personally, more or less intimately, over three hundred teachers in high schools; about a third of these are science teachers. Of these science teachers only about a dozen have ever expressed any ideas that would indicate radically progressive notions in matters social, political, ethical, theological or educational; and more than that number have expressed attitudes that would be considered not merely "conservative," but positively regressive in each realm of thought.

The progressive teachers of my acquaintance are predominantly teachers of English and of mathematics. Even in matters purely technical, the majority of the science teachers that I know are either ignorant of the newer ideas about evolution, or extremely suspicious of anything that threatens to undermine the safe and sane doctrines that they acquired as students in college. They are temperamentally static and

their "scientific training" has not made them any more open-minded or progressive. The science teachers of my acquaintance are not more open-minded or more free from prejudice than other teachers, or than other people in various occupational groups. The small number of science teachers who are open to new ideas are probably open-minded not because of their scientific training. The words *foreigner, Jew* and *socialist,* for example, produce in the minds of some four-score science teachers that I know the same kinds of reactions as they do in the minds of just ordinary chauvinists, hooligans and philistines, respectively.

In short, I have found no indication that these science teachers are more deliberate and analytical and systematic in forming judgments upon new problems than teachers of other subjects; nor that they are more progressive in adjusting themselves to new ideas—to say nothing of being on the look-out for new ideas; nor that they are freer from prejudices and conventions of thought.

However, notwithstanding the rather discouraging results of a canvass of my colleagues, I still believe that science teaching offers better opportunities for cultivating certain intellectual virtues than the teaching of other subjects.

A person temperamentally or habitually dishonest can not be expected to teach honesty, if indeed honesty can be taught at all. But even if honesty can not be taught at all, as some maintain, the laboratory presents the opportunity for learning to discriminate between certain truths and certain superficial resemblances to truth—which is in itself a great gain. That is, if a person is to be dishonest, it is desirable that he at least know that he is dishonest, so that he deceive not himself, however he may treat others.

The laboratory presents opportunities for testing objectively the accuracy and coherence of the pupil's language; it devolves upon the teacher to establish an ideal of accuracy. A number of pupils will come to a more or less conscious generalization of the idea, and a more or less deliberate acceptance of the ideal, without any assistance whatever; for most children, however, the teacher's help is needed or the experience in the laboratory will have no "training" value. In the laboratory, too, we may test the logic of a classification, for the inclusion of incompatibles or for the faulty distribution of coordinates, etc. Going through such an exercise a number of times will perhaps develop a certain skill that will show itself in the reduced time of the *n*th performance, but it will not establish a mental habit unless somehow the teacher makes the practise in such discrimination a part of the conscious purpose of the child.

The teachings of language are arbitrary; they exercise the memory (not in the gymnastic sense, of course) and cultivate faith in authorities. The teachings of mathematics are formal and deductive, and, as

a rule, they leave no room for individual initiative or independence of thought. The teachings of history, so far as the *facts* are concerned, must also be more or less arbitrary and authoritative. But history teaching and language teaching, and even mathematics teaching, are rapidly becoming humanized in a modern, scientific sense.

The teaching of science, introduced into the schools in comparatively recent times, has been too much influenced by the methods of the older teachers of the older subjects. While the other subjects have felt the influence of the scientific age, the science teachers have failed to develop the possibilities of their own material. Science teaching needs indeed to be *humanized,* but not by being assimilated to the mechanical, formal teaching of the older school disciplines, but along the lines of its peculiar possibilities. We must not expect general discipline from special work in science; but we must turn to general application the special ideas and principles of science.

We can humanize our science teaching by relating it to the idea of human *achievement.* Achievement in science is an essential part of human history, and a very significant part. It can be made to appeal to the imagination and to stir the emotions quite as effectively, and to as good purpose, as achievement in other directions. The history teacher may be obliged to neglect this side of his history—at any rate, he generally does neglect it. But the science teacher can not afford to detach the great ideas which he wishes to impart from the animal species in the course of whose evolution these ideas emerged. We can humanize our science teaching by making clear the idea, and making it impressive, that human progress, as illustrated by the growth of science, depends upon most intimate kinds of cooperation; by making the pupils feel the interdependence of the living of all lands, by making them feel our dependence also upon those who have gone before. High-school girls and boys can appreciate the fact that the reason why one carried on the shoulders of another sees farther than the latter is not necessarily the superior optical apparatus of the first.

We can humanize our science teaching by making clear in the thought of the pupil the idea that the progress of science consists of a successive refinement of hypotheses; by teaching them to appreciate the difference between hypothesis and fact, on the one hand, and between fact and conclusion, on the other. We can teach an appreciation of the value of facts as the only sound basis for judgment, and we may hope to establish the habit of searching for facts during the suspension of judgment.

We can humanize science teaching by giving up the attempt to make scientists out of high-school students; that is not our function. It is our business not to make scientists, but to make as many children as possible appreciate first the service of science, and second the method

of science—as a tried and worthy method of solving certain types of human problems. We may incidentally discover that here and there a pupil is worth directing into a scientific career; but that is a part of the general purpose of the school, and not of the specific purpose of science teaching. Now, if we are to make young people appreciate the service of science it will not be merely by establishing in their minds bonds of association between important inventions and the names of the inventors: it will be by making them *feel* the downright solidity of thoroughness and accuracy and honesty and clear vision. If we are to make them appreciate the method of science it will not be merely by helping them to memorize concrete facts, rules of procedure and abstract formulas, it will be by making them take part in analytical thinking about real problems until they have arrived at an explicit realization of what constitutes a valid way of thinking about problems.

We can humanize our science teaching by making the pupils realize that we have no final truth; that science, like life, is a constant becoming. This ought to do something to counteract what has been called the "superstition of science"—that attitude which continues the method of the medieval dialectician, but substitutes some new-sounding phrases for the older categories. The person who confounds evolution with the doctrine of natural selection, the one who has nothing to do with ions because these threaten to disrupt the atom which he acquired in his youth—these are among the men and women with closed systems of thought, who may indeed speak of chromosomes and valency, but who never are scientific.

We need science teachers more than ever. These should be first of all teachers. But the usual tests require that they shall be then familiar with reasonably large bodies of information about plants and animals, or about wheels and polarities, or about atoms and reactions. What is needed more than large bodies of information—which any reader can get out of a half-dozen books—is a habit of clear and honest thinking. This is not to say that the quality in question is not desirable in teachers of other subjects. It is simply to say that in the selection of teachers of science this qualification has been too greatly overlooked.

THE PROBLEM FOR THE RURAL SCHOOL

BY PROFESSOR J. B. SEARS
STANFORD UNIVERSITY

WHAT is the real problem now before the rural school? This is a question that is being asked on all sides, and by an increasing number of people. Professional and laymen alike are trying to find out, not only why it is that the rural school has been so much neglected, but in what specific ways it has been neglected; and, what is even more important, what the rural school is really obligated to do.

It is true that the praise of the district school has been sung almost from the dawn of its existence; that the poet, the essayist and the orator have all referred in endearing terms to the little red schoolhouse on the hill; to the district school, the pride of our land and the embodiment of the best principles of American democracy, etc.; and we have continued to believe things about the country school in general which we knew did not apply to any particular case in point. Thus the real and the ideal have managed to avoid a conflict till the issue has become very pronounced, not because the school is any different from what it was a half-century ago, but because the demands upon it have increased in complexity, and so intensified its problem, which it has never solved any too well. And it is because the facts of its inefficiency have been accumulating so rapidly that during the past decade a wealth of literature, technical and otherwise, has been finding a ready consumption. Just what these facts are we ought to know. No policy can be laid down which is in any sense comprehensive if it is not made in the clear light of the real nature and extent of those problems which it is the function of the rural school to solve or help to solve.

It is well to remind ourselves from time to time that in the minds of the founders of our nation, as well as in our own thinking, education is conceived to be essential to our form of government. Yet, if we examine more closely to see just how the school has been handled by the state, we may quickly find that it has never been a definite part of a constructive national or state policy in the broad and comprehensive sense commonly accepted. For while in theory the school has been instituted and espoused as an instrument to be used in the development of political and social permanency, yet in very fact we discover that when this principle or ideal, which is referred to in almost every state constitution, becomes a reality, it is a state concern too much in name only, with such vital matters as support left, in the final analysis, to the locality

for which the school is constructed. (Fortunately notable exceptions to this are increasing in number.) But where this is true, it is plain to be seen that in a district where there is little taxable wealth there must be either a very high tax rate, or the alternative of little school money, and hence a poor school. Thus the state may levy the school tax and distribute it, but when it levies a higher rate in one district than in another, or distributes less to one district than to another, even though that district may actually have more children to educate, it would seem that there are at least some very important ways in which the schools are not state institutions.

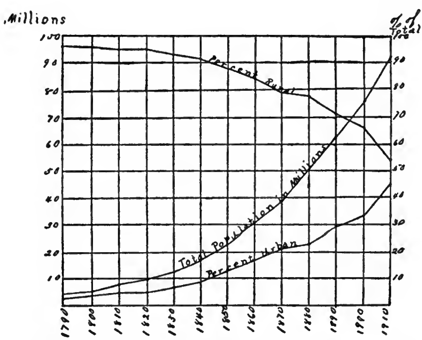
It is because of this interpretation by the state that the rural school, which along with many other phases of rural life, being left desolate by the accumulation of wealth in the cities, has suffered. And by comparison with the city schools its suffering has been very real. For the rural schoolhouse of to-day is of the same general type that was in vogue a hundred years ago; a large percentage of its teachers have not only had no professional training, but are teaching for the first time; the teacher rather rarely succeeds herself, and is often succeeded by one or two others within a single year; one teacher has all the grades and teaches from fifteen to thirty classes daily; poor library and no laboratory apparatus, save some dust-covered curios bought from a clever agent by an unsuspecting school director; no play apparatus or director; no domestic-science or manual training; little agriculture; and little or no supervision. This may not be a pleasant picture, but for the United States as a whole it is not badly overdrawn, in spite of many excellent signs of awakening here and there. But it is only by comparison, point by point, with a modern city system that the real poverty of the country school becomes apparent.

These are the conditions we are becoming conscious of to-day, and they are provoking a serious study of the real underlying troubles. The teacher, the preacher, the farmer, the banker, the legislator, the president, all are asking the same fundamental question, each from his own particular angle. The teacher sees that the country school is not vitally tied up with its problem, the preacher finds that the country church is disappearing, the banker realizes that a more successful handling of the farming problem will aid his business, legislatures are looking to the conservation of the soil and the destruction of farm pests, the national government has looked after the important matter of credit for the farmer, and the report of the Roosevelt Country Life Commission speaks in similar terms. Thus when we are counting the defects of the country school we are only counting one group of symptoms. The trouble is deeper and more far-reaching than any one institution. The problem is therefore not the mere problem of the school, but the whole problem of country life.

We are to ask, then, not what are the present limitations of the country school, but what are these big vital problems which are of such vast concern as to claim the active attention of so many men in high authority. We are concerned to know what is the real function of the country school, and whether or not it is part of a conscious program for handling these larger issues, or whether the state has merely said: let there be a country school, and then sat quietly by with folded hands. This latter may still be entirely too true, but if so it is high time that the state should be taking the constructive side of its problems more seriously.

The country problem is one for all people, urban as well as rural, for in its last analysis the welfare of all rests flat down upon the land. That is not too broad a statement, for though other industries undoubtedly have a future in this country, yet we can not fail to see that it is America's broad and fertile acres that determine her responsibility among nations, as well as her future economic position. Whatever affects the occupation of farming, therefore, is of consequence to the rural situation in general.

A glance at the accompanying chart will impress one with at least one very important change that has taken place in the past century and a quarter.



When our nation was first established there was almost no city life at all, and even in 1800 only 4 per cent. of the people lived in cities of 8,000 inhabitants or over. By 1850 this had increased only to 12½ per cent., after which its increase is very rapid, till in 1910 almost half our total population lived in the city. At the rate of the past decade, the next census will show that here, in the greatest agricultural nation in the world, the few are feeding the many. This means over ninety million consumers, with only about forty-five million producers.

What this change has meant is difficult to state in few words. This shifting in population is effect as well as cause. Parallel with it has gone the development of factories, which has taken many industries to the city which were once a part of farm life. And it is to be remembered that whatever affects the economic life affects also the social life in all its institutionalized expression. So the home life on the farm, the country church, the country school, all have been influenced by these changes. Likewise with the development of machinery, farming is being made more and more scientific. Hand labor is therefore disappearing, and cooperation between farmers along with it. So the old life on the farm, that was in itself a broad education, is gone, and it is the legitimate function of the school to fill this gap. But it is not yet filled, for legislation has constructed a school adapted to the old days, when wealth was evenly distributed, and democratic ideals were best met by systems of local control and local support.

In this age of city-building it is interesting to note the tendency toward the operation of farms by tenants. In 1880 there were 74.5 per cent. of the farms operated by owners. In 1910 this had decreased to 62 per cent. At this rate the absent landlord will be supreme ruler in the course of a few generations. The accompanying table will be illuminating in this connection. True, the price of land has raised

Year	Per Cent. of Farms Operated by			
	Owner	Tenants		
		Cash	Share	Total
1910	62.0	14.0	24.0	38.0
1900	64.7	13.1	22.4	35.3
1890	71.6	10.0	18.4	28.4
1880	74.5	8.0	17.5	25.5

(having almost doubled in the past ten years), and it is necessary, therefore, for each succeeding generation to remain as tenant a little longer than the generation before; true also that the number of farmers who are retiring to a quiet city life, but holding their farms, is increasing; and true that city investors are buying land but not farming it. So, if it is not a wilful desertion of the farm in all cases, it is nevertheless bringing the question of absent landlordism among us, and that is not a wholesome tendency. It should be remembered that this has been the tendency in the face of a vast supply of cheap government land, which will soon be a thing of the past. And now, add to this the further fact that the number of farms under mortgage is on the increase, having risen from about 28 per cent. of all the farms in 1890, to nearly 34 per cent. in 1910, and we seem to complete the evidence that something needs to be done if we are to succeed as an agricultural people.

It will only darken the picture to add that the per cent. of illiteracy

in the country is just double what it is in the city, and this despite the fact that nearly all the illiterate immigrants who come to this country reside in the cities.

The problem of rural life from an economic viewpoint seems broad enough, and the task of the rural school looms large; yet we must add, that while 53.7 per cent. of the people in the United States live in the country, the per cent. of children of school age (6–20) who live in the country is 58.5. That is 53.7 per cent. of the people have to educate 58.5 per cent. of the children; while the other 46.3 per cent., who live in the city, have to educate only 41.3 per cent. of the children.

From the social side there is a problem nearly as great. For even if the telephone, the rural mail delivery, the automobile, and the good roads movements as doing much to make possible a better social life, yet where is the theater, the moving pictures, the library, the high school, the club house, the athletic fields, the parks, the shop windows, the bright lights, the crowd? These are in the city, and they call loudly to the young life in the country. Isolation is the word in the country which corresponds to the word congestion in the city. The play side of life is too narrow, and people die of lonesomeness.

It is not the purpose of this article to suggest the country school as a panacea for all these social, religious, intellectual, and economic ills, but it would urge that a systematic study of the whole problem should be made in order that the appropriate function of each rural institution may be more scientifically determined. What is said here is true only of the United States as a whole, and not of any one section in particular. But a constructive effort should be made in every community to understand the problem as it exists there. And then for its solution we need, not so much a new institution, as a reinterpretation of the function of the institutions we already have. The rural church ought to exist, but it must teach wholesome religion in the place of medieval creeds, and build community churches instead of Methodist or Presbyterian churches. In like manner, the school must drop some of its traditions, quit luring children away to the city, and begin to reconstruct in terms of country life. It must be a state school in more than name, and be a school for old as well as young. The schoolhouse must be open for all kinds of social and intellectual programs, and become the center of community life.

But this can not be done by the various rural institutions working singly, at different fragments of the problem. Concerted effort is needed, and we can not propose a safe plan of reconstruction for the school, or for the church, or for social life, until we know more about the present status and more about the facts which must underlie any constructive program.

The Country Life Commission is a notable example on a large scale

of what ought to be done for every country community. The state should probably take the lead, as Ohio is doing in her rural school survey, and make a complete study of the whole of her rural life. Until this is done, the school and the church will cling to tradition, and the broad cultural side of life on the farm will be neglected. And so long as this is neglected, that long will the social reason for deserting farm life exist, and the drift to the city continue.

If it is not in the province of the rural school to assist in the solution of these problems, by giving to the children a proper understanding of the rural conditions, by providing a center for the social and intellectual life of the community, then all its traditional procedure, all its narrowness which is being so broadly criticized, is justified and represents efficiency. Or putting it another way, if the government, which theoretically exists of, by and for the people, does not attempt to meet these destructive tendencies in our national life, it is following an outworn social and political philosophy. And if the state does try to meet them, and does not use the rural school as a means to that end, it is ignoring one of the most efficient agencies it has, and one whose very meaning as an institution rests in its capacity to render this broad social and intellectual service to farm life.

The problem of the rural school is therefore the problem of the rural people. It is not as narrow as a book, but it is as broad as life. The school must accept its share in these large social, economic, and intellectual responsibilities, and stand ready to assist in the execution of a broad constructive social policy, whose aim it shall be to make rural life not merely tolerable, but wholesome and attractive.

THE EVANESCENCE OF FACTS

By Dr. JONATHAN WRIGHT

DIRECTOR OF THE DEPARTMENT OF THE LABORATORIES OF THE POST-GRADUATE MEDICAL SCHOOL AND HOSPITAL

IN looking over some old portfolios, I have lately dragged to light elaborate notes which relate and discuss various facts set forth by the laboratories of this and other lands. Yellow with age, but vivid with the interest and bursting with the importance with which the scientific environment of the day invested them for me, they have set me musing on the vanity of human interests, especially the vanity of scientific interests. I remember the sonorous periods which reverberate from university platforms, the mottoes flaunted on the title page of many a scientific journal, "To the solid ground of nature trusts the mind which builds for aye." The pride, the pomp and circumstance of war burn in a feeble flame when compared with the assurance which fills the bosom and exudes at the lips of the man of science when he contemplates the firmness of the pedestal upon which he stands, the rock of ages, the steel concrete foundation against which dash in vain the skepticism of the scoffer and the voluble waves of theory and ratiocination.

For is not this substructure the product of the unerring interpretation of vision, hearing, of smell and taste and feeling? Vision aided by spherical glasses, aberrations of light and obscurity of outline corrected by the proper means, sound amplified by vibrating plates and confined by hollow conduits, smell—well, there is some doubt about smell—it is a recessive—however, the solidity of the ground of nature as betrayed by the senses, that is, most of them, is such a contrast to the airy superstructure built by deductive reasoning and by the imagination, unrefined by submission to the crucial test of experiment, that it is not worth while to dwell on the fallaciousness of the senses.

However, to go back to my old notes, yellow with age, musty with the dust of the intervening years, like the moths and insects from Faust's old coat when Mephistopheles shook them out, they may sing:

> Willkommen! Willkommen!
> Du alter Patron,
> Wir schweben und summen
> Und kennen dich schon.

But I recognize them only as a particularly uninteresting and lousy lot of lowly organisms. I am not at all tempted to utilize them as foundation stones for the imposing edifice I was secretly longing to build when

I took up the old portfolio. What is the matter with the facts? They seem just a little tarnished; the mind is not tempted to gild them over or rub them up, the imagination refuses to endow them with those winged words which carry newly quarried facts bright and shining to the work table of the appreciative student, unhaunted by any shade of historical perspective. Evidently the time to work a fact into the masonry of science, "the solid ground of nature" upon which her trusting and unsuspicious, non-historical, scientific children love to build, is when it is fresh and when the mortar will cling to it. Coat it over with the incrustations of criticism, the mould of age, and it must be fresh hewed to the point of losing its identity—its susceptibility of identification, I mean,—before it can be appreciated as a part of "the solid ground of nature"—made solid of course by eyes, not really myopic or hypermetropic when they have their errors of refraction properly corrected, made solid in a word by the unfailing, unerring use of sense—a veritable fact, not an old fact, of course, but a new one. It is true that an old fact is often not just the thing to trust to, but a new one, and new ones are so easy to find if you have not wasted your time with the old ones, lends that solidity of support which we love to contemplate in the hierarchical press of science. It unfortunately has come to look a little suspicious in the secular press, but a new fact, really approved by the hierarchy of science, unsmirched by any touch of the imagination and free of any suspicion of deductive birth, is a thing of beauty if not a joy forever. The old facts, though they continue to sing:

> Du hast uns gepflanzt;
> Zu Tausenden kommen
> Wir, Vater, getanzt.

are, I must confess, a pretty "poor run of shad." It is true it does not seem just the way a fact should behave. Its vintage should improve with age. It is undeniable, however, that in really choice circles of science, the old facts are not looked on with favor.

The imagery of Shakespeare, the flowers of eloquence in Demosthenes, need no burnishing, no drapery to hide their age, but the atoms of Democritus and the spheres of Ptolemy need considerable correction, and the cloud of insect facts which swarm up from my old yellow sheets, if not simply disgusting, are at least uninspiring. Is it possible then they lack something? A fact, it is true, should lack nothing. It should stand alone unshamed in its nakedness—for is it not the truth? Is not the truth divine?

The concatenation of circumstance should have nothing to do with it. The contemporaneous adornment it borrows from its environment must be non-essential. I do not know how many facts can pass through this crucible of criticism unscorched. All that I can say is that I have never

met with an old fact among the countless tons of them under which our library shelves groan which I am certain would not betray to the eager experimentalist of whom we are so proud many a crack and many a blemish. To the observant dilettante or to the ingenuous, earnest student—if one can be called such who flits often across the whole domain in which truth is sought, it is apparent that different tests are applied to the genuineness of the information acquired.

The physicist concludes he has something material because when his electrons are fired through a tube he can see the flash or hear them ring a bell and so count them. The physiologist or the biochemist concludes a certain organic juice is present because he can perceive the effects of its diastase or the serologist can see the clouding or clearing of the fluid in his test tube. The geologist draws certain conclusions from the scar on the hillside or river bank, the archeologist from the presence or absence of certain forms of the architrave or of certain metals in the implements he finds. Such evidence for the establishment of facts as is satisfactory to the sociologist or psychologist or archeologist is scorned by the astronomer and the physicist, while the statistician is still more intolerant. "Chacun à son métier" with a shrug of the shoulder is the answer given to extraneous criticism by the delver in each domain for hidden facts, yet in a certain tacit way it is felt that the physicist in the making of a flash or in the ringing of a bell, and the statistician in counting them, has really the better grasp on reality, until along comes some king of physicists like Lodge or Crookes or some skilful fencer like Bergson, some iconoclast like Driesch, and shows that these things are not physical at all, but are knots in the ether or metaphysical entirely, or the Lord knows what, and the dilettante says (to himself, if prudent): "Well, what is the test of Reality anyhow, what is a fact? It seems to depend on the method"; and he goes his way with his own private opinion of the claim that the methods of science are something sacrosanct and apart from other demonstrations of the grounds of belief.

Truth is eternal, of course, but whether there are some truths which are not facts or some facts which are not truths may be left to the logicians, and other former inhabitants of the fanes of science, discredited dwellers in the temples of truth. The mantle of the sophist, the glamor of the logician clothes other forms and illuminates the halls of other shrines. Other prophets are now accustomed to have their dictum greeted as if: "A fonte relatum Hammonis." The same befitting solemnity, the same sepulchral dignity, again clothes the dispenser of new truths as of old shone around the prophets with the oriflamme of truth. The modern prophet, however, draws his inspiration not from the gushing fountains of the imagination set playing by some Pagan or Christian divinity, but from the solid foundation of facts laid down by the un-

erring and unfailing senses, aided of course usually by the microscope and the stethoscope, but solid fact nevertheless. No deduction need apply; no fiery imagination can play around a fact. The supreme tragedy of nature, Huxley reminded Spencer, was one of his theories killed by a fact. Reason indeed must play a minor rôle in the new theocracy. Man indeed has been accustomed to lean upon it but:

> Ein wenig besser würd er leben
> Hättest du ihm nicht den Schein
> Des Himmels Licht gegeben
> Er nennt's Vernunft und braucht's allein
> Nur thierischer als jedes Thier zu sein.

When the fact comes to be builded into a structure of any use to mankind, of course the "light of Heaven" must be employed, but not for a fact alone. That shines by its own effulgence. It would appear, I confess, that the fact should shine for the babe as well as for the sage, but after all sight and hearing and smell (that Judas of the senses—why is it always necessary to reckon with this atavistic weakling?), need interpretations; certain conclusions, not of course deductively but inductively—mark the difference—must be drawn from those peripheral stimuli which ring a bell in the caves of thought. This is entirely different from the circuitous ratiocinations which formerly disfigured the face of science. Pure science is direct induction, as distinguished from the impure science in which the heavenly beacon plays too conspicuous a part. Truth is apt to be lost if we get too far from the peripheral stimuli; just how far, it is at present inconvenient to determine. At any rate, it is now universally recognized that the sources of knowledge are entirely different from former sources of knowledge, so elongated in degree that the difference is fundamental. Without this appreciation of the difference between an interpretation of external peripheral stimuli, revealed to us by the senses, and the conclusions arrived at by the philosopher who sat in his tub or by the deductive sage who constantly contemplated his umbilicus, one is apt to lose sight of the glory of modern science. One method we readily believe was fallacious, the other we know to be unfailing.

This change in the methods of science began when the old method had advanced about as far along its old paths as we have along the new ones. The change (it is uncertain whether we are to reckon its inception from Roger Bacon or Lord Bacon) gradually became so emphasized that under Cuvier at the French Academy even discussion was frowned upon. It is true that France is no longer the exclusive home of science or even the chief home of science. Science finds a favorite residence amidst the fogs of Germany, where, owing to the idiosyncrasies of etymology, discussion is a tiresome, but alas, not a neglected occupation. Indeed, there is well-founded suspicion that science has advanced

as much by discusssion as by direct observation, but there seems to be a smell of heresy about this. At least the phenomenon is familiar. The cash-register method of Cuvier, whereby facts were supposed to be recorded but not discussed, presents some flaws in its title of supremacy. Possibly this is because there is really some incompleteness in application. The interposition of the function of the cerebral cortex seems to a certain extent unavoidable. In so far then we are, even with Cuvier's classical conception, obliged to accept some modification. "Das Ding an sich" is essentially a figment of the reasoning faculties of the German mind, and the attempt to grasp it in the interest of pure science has always been somewhat of a failure.

In musing over these old notes then, I am led far astray in an attempt to explain just why the old facts do not present that alluring aspect to me which they once did. True in the words of the poet I may well question:

> Are they still such as once they were?
> Or is the dreary change in me?

Indubitably the "warped and broken board" of the poet's simile does not take the painter's dye as it did when fresh sawed from the mill. The chill of age we know brings the carping criticism to the front which the blush of youth hides behind its inexperience, but I never heard that wisdom was the latter's handmaiden rather than the servant of the former. Nevertheless, it is well to compare the inspiration of the recent revelation with that of the discovery of the old knowledge and the force of the suggestions I have shadowed forth in my musings will not appear entirely negligible.

What then becomes of the old facts? Peripheral stimuli, transmitted from without through the organs of special sense and interpreted by the cortical gray matter of the brain, have eventuated not only in records carved on stone and scratched on brass, but they have left their still more lasting impress on the social inheritance of countless generations of men—evidently from far beyond the period when historical records began to be preserved for us. The peripheral stimuli, direct observation, with as little interposition of gray matter, illuminated with as little of the heaven-bestowed light as possible, were the origin of these beliefs—these facts—just as are the red rods we see by the help of convex glasses which we now call tubercle bacilli.

The archeologists tell us that time plays curious pranks with the most resistant and stubborn materials. For many years the old story of the Phœnician sailors' discovery of glass beneath their camp fire on the sea sands of the shore was an attractive one, but evidently the manufacture of glass goes far back of the time when the Phœnicians were masters of the sea. In some of the material dug out of the soil, once pressed beneath the feet of men of the most remote antiquity, a streak

of a little different color is noted. Carefully brushing away this mouldering matter, in the center is still found a thin streak of glass. The dust in which was encased this flint-like product of man's ingenuity was once glass too, but the whole has crumbled away to this mere sliver which alone serves to betray the nature of the whole. In this crumbling disintegration we may see an apt illustration of how those facts, yielded by direct observation to the cerebral cortex of primitive man, have ceased to preserve their recognizable outlines. In order to get some idea of what they were, the archeologist must go with the sociologist to the study of those remnants of primitive man still to some extent uncorroded by the pressure of the environment of civilization. Malay magic, the astounding beliefs unearthed by modern travelers, innumerable legends fantastic to the civilized mind, so devoid of point and so obscure of origin as to be not only incomprehensible but even devoid of interest, are the revelations which greet the inquirer. At first without a clue, this is simply a bewildering mass, confusion thrice confounded. Gradually, however, it becomes evident to the student that all this has arisen from the direct observation of an external environment, of an ever-pressing, an ever-intruding nature with which primitive man struggles. His method of the acquisition of facts, however, we find quite similar to that of Cuvier—observation, assertion, suppression of ratiocination, ignorance of logic—the true inductive method.

When Diogenes studied the universe from his tub and bade Alexander stand out of his sunshine, he probably did not realize that Alexander had pushed the forest back and had started the conquest of tropical nature and had given Diogenes time for the study of his umbilicus, given him the leisure for reflection. The savage has it not. So Diogenes and his tribe knew not direct observation and concluded they could get along without it—in spite of the Stagyrite, who was soon to make an abortive attempt to weld the two weapons being forged for man in his future search of the truth. Back and forth these two tendencies of man in his quest surged for thousands of years. Finally man, by availing himself of the invention of the convex glass found in the ruins of prehistoric Nineveh, by perfection in the accuracy of the measurement of the curves and angles studied by Euclid and his predecessors, by throttling those who to preserve their own autonomy had hitherto prevented it, brought about the bursting forth of a flood of external stimuli—new facts pressing on man, intruding on him like the primeval forest did on his primeval ancestor, fairly forcing him into Cuvier's attitude—record facts, never mind what they mean—there is no time for the study of the umbilicus at present.

And so again their evanescence becomes manifest. Crumbling disintegration sets in. Time with its mordant acid and alkalies encrusts the bright new glass. Back and forth vibrate the forces of the micro-

cosm as well as those of the macrocosm, the spiritual tendencies and the intellectual methods of man. It is a universal law. Perhaps a static equilibrium means death—all things tend to that so far as we know. But will it never be possible to establish a unity of the two methods of seeking truth? Surely they are not wholly antagonistic—they are not essentially hostile forces like attraction and repulsion, like positive and negative electricity. Can we not have, now Cuvier is dead—peace to his ashes—a little pause—a little time for discussion, a little space for a contemplation of the umbilicus—a little space for logic and criticism in the Centralblatts and other cash registers?

It *is* the concatenation of circumstance, to repeat a former phrase, and not the fact itself which lends it charm. The naked truth no one ever saw, except the nymph who perished at the sight. The facts of sense, like those of the prophet, like those of the poet, like those of the philosopher, are relative, not real, and the results of such musings as I am indulging in can lead the seeker after truth only to the conclusion that each is but the facet of a whole of which our conception is the less complete and the narrower the more exclusively we tread the path illuminated solely by one aspect of the truth. He who knows nothing of the imagination, of the workings of logic, of the inspiration of the poet and the prophet, he who is ignorant of the past and finds no comfort in the speculations of the prophet as to the future, is badly equipped for the interpretation of the impression of the senses. No life is a rounded life without a touch of something more than that of materialism. The method of science which rests solely on that is fatally defective. It withers the powers of youth and it favors the approach of a premature intellectual sterility from which there is no escape but in the silence which falls upon those who have not heeded the warning in their youth.

Thus musing, the old yellow papers are cast aside for fresh tablets, but with the consideration that in science it does not matter much, since the evanescence of facts, not at once built into the structure which forms the woof and web of contemporaneous thought, is soon evident to the seeker after truth if he digs deep enough.

FOREIGN ASSOCIATES OF NATIONAL SOCIETIES, III

By Dr. EDWARD C. PICKERING
DIRECTOR OF THE HARVARD COLLEGE OBSERVATORY

A PAPER entitled "Foreign Associates of National Societies" was published in The Popular Science Monthly, Volume 73, page 372. A second paper on the same subject is contained in Volume 74, page 80. Lists were prepared of those who had been elected as associate members in the physical and natural sciences, by the seven leading societies of the world. To secure impartiality, the great nations of the world were arranged in the order of population. Omitting China and Japan they are Russia, United States, Germany, Austria, Great Britain, France, Italy, and are here designated by the letters, R, U, G, A, B, F, I. The societies are the Imperial Academy of St. Petersburg, the National Academy, the Royal Prussian Academy, the Royal Academy of Sciences in Vienna, the Royal Society of London, the Institute of France, and the Royal Academy of the Lincei. All the foreign members of a society are regarded as foreign associates. The list already published contained all persons who were foreign associates of two or more of these societies. It may be claimed that this is the most unprejudiced list of eminent men ever selected. It would seldom happen that any person, not worthy of the honor, could be elected into one of these societies. The chance that he could be elected into two is so small that it may be neglected. The first list was published in 1908, and since then more than a third of the members have died. Moreover, under existing conditions, it will probably be impossible for many years to secure an unprejudiced election of foreigners into these societies. It appears, therefore, to be the last chance to prepare an impartial list of the men most eminent in the physical and natural sciences, in the opinion of their contemporaries.

Table I. contains, in successive columns, the names of each man selected as described above, his residence, his department of work, date of birth, age on election into each of the societies and, if not living, his age at the time of his death. The date of the list is January 1, 1914, but the last column is probably complete to January 1, 1915. The letter *a* is added to indicate those men elected since 1908. It will be noticed that, in three cases, men have been elected and died during the last six years.

Table I. may be discussed in a variety of ways. The numbers may be grouped according to the societies, countries or sciences. Examples of some of the conclusions which may be derived are given below.

Table I

List of Members

Name	Country	Science	Birth	R	U	G	A	B	F	I	D
Agassiz, A.	U. S.	Zoology	1835	...	*31*	60	54	56	52	53	75
Albrecht, C. T.	Prussia	Geography	1843	...	...	...	...	...	67	64	*a*
Appell, P. E.	France	Mathematics	1855	56	...	...	...	...	*37*	49	*a*
Arrhenius, S. A.	Sweden	Physics	1859	44	49	...	48	51	52	52	...
Auwers, A.	Prussia	Astronomy	1838	35	45	*28*	56	41	54	50	...
Bachlund, O.	Russia	Astronomy	1846	*37*	57	...	...	65	49	...	...
Baeyer, A. von	Bavaria	Chemistry	1835	57	63	*39*	50	50	51	59	...
Bakhuyzen, v. d. S.	Holland	Astronomy	1838	...	...	...	...	...	58	72	*a*
Barrois, C. E.	France	Geology	1851	46	57	...	61	62	*53*	58	*a*
Beneden, E.	Belgium	Zoology	1846	56	...	41	56	...	55	53	64
Bonnier, G. E. M.	France	Botany	1853	59	...	...	61	...	*44*	...	*a*
Bornet, E.	France	Botany	1828	74	73	...	...	...	*38*	...	82
Boss, L.	U. S.	Astronomy	1846	64	*43*	64	...	...	...	...	66*a*
Brögger, W. C.	Norway	Geology	1851	47	52	...	61	51	53	62	...
Bütschili, O.	Baden	Zoology	1848	46	...	*49*	56	...	...	...	...
Cannizaro, S.	Italy	Chemistry	1826	63	...	62	63	63	68	*47*	84
Chauveau, J. B. A.	France	Agriculture	1827	...	...	...	...	62	*59*	63	...
Christie, W. H. M.	England	Astronomy	1845	47	...	...	...	*36*	51	...	...
Ciamician, G.	Italy	Chemistry	1857	55	...	...	...	...	56	*36*	*a*
Crookes, W.	England	Physics	1832	...	81	...	...	*31*	74	72	...
Darboux, J. G.	France	Mathematics	1842	53	71	55	65	60	*42*	48	...
Darwin, G. H.	England	Geography	1845	62	59	...	63	*34*	62	52	68
Davis, W. M.	U. S.	Geography	1850	...	*54*	60	...	...	63	...	*a*
Deslandres, H. A.	France	Astronomy	1853	...	60	...	...	...	*49*	55	*a*
Dewar, J.	England	Physics	1842	...	65	...	...	*35*	...	67	*a*
Ehrlich, P.	Prussia	Biology	1854	...	50	...	...	56	...	53	...
Engelmann, T. W.	Prussia	Biology	1843	...	...	*55*	52	...	52	58	66
Fischer, E.	Prussia	Chemistry	1852	47	52	*41*	50	47	48	47	...
Gaudry, J. A.	France	Geology	1827	...	...	73	...	68	*55*	70	81
Geikie, A.	England	Geology	1835	73	66	54	60	*30*	56	63	...
Gill, D.	England	Astronomy	1843	42	55	47	...	*40*	53	63	71
Golgi, C.	Italy	Zoology	1843	62	...	...	60	...	...	*47*	...
Gordon, P.	Bavaria	Mathematics	1837	...	...	*63*	...	...	67	67	75
Graff, L. v.	Austria	Zoology	1851	...	54	49	*48*	...	...	...	...
Groth, P.	Bavaria	Geology	1843	40	62	...	...	68	...	62	...
Haeckel, E.	Saxony	Zoology	1834	...	...	...	38	...	...	65	...
Hale, G. E.	U. S.	Astronomy	1868	...	*34*	...	42	41	40	43	*a*
Hann, J.	Austria	Geography	1839	51	...	50	*33*	...	...	...	...
Heim, A.	Switzer- land	Geology	1849	...	64	...	...	47	57	...	...
Helmert, F. R.	Prussia	Geography	1843	64	...	*57*	...	65	56	54	...
Hering, E.	Saxony	Biology	1834	71	...	...	61	68	...	65	...
Hermann, L.	Prussia	Biology	1838	...	...	...	...	67	...	73	*a*
Hertwig, R. v.	Bavaria	Zoology	1850	55	...	*48*	55	...	...	...	...
Hilbert, D.	Prussia	Mathematics	1862	...	45	...	49	...	...	41	...
Hildebrandsson, H.	Sweden	Geography	1838	69	...	...	...	...	74	...	*a*
Hill, G. W.	U. S.	Astronomy	1838	...	*36*	...	...	64	65	75	76
Hittorf, W.	Prussia	Physics	1824	...	...	*62*	87	...	76	80	...
Hoff, J. H. van't	Prussia	Chemistry	1852	43	49	*44*	44	45	53	49	59
Hooker, J. D.	England	Botany	1817	41	66	54	...	*30*	49	58	94
Huggins, W.	England	Astronomy	1824	77	80	71	...	*41*	50	59	86
Jordan, M. E. C.	France	Mathematics	1838	57	...	...	...	...	*43*	57	...
Kapteyn, J. C.	Holland	Astronomy	1851	57	56	...	...	...	58	...	*a*
Karpinski, A.	Russia	Geology	1847	*49*	...	...	50	...	...	51	...
Kayser, H.	Prussia	Chemistry	1853	49	...	...	...	58	...	...	*a*
Klein, F.	Prussia	Mathematics	1849	46	49	...	51	36	48	34	...
Koch, R.	Prussia	Biology	1843	41	60	*61*	60	54	60	45	67
Kohlrausch, F.	Prussia	Physics	1840	54	61	*55*	...	55	...	59	70
Kronecker, U.	Switzer- land	Biology	1839	...	62	...	...	...	...	58	75
Lacroix, A.	France	Geology	1863	46	...	...	47	...	*41*	45	*a*
Lankester, E. R.	England	Zoology	1847	48	56	...	...	*28*	52	51	...
Larmor, T.	England	Mathematics	1857	...	51	...	...	*35*	...	54	*a*
Le Chatelier, H. L.	France	Chemistry	1850	62	...	55	...	...	*57*	...	*a*

TABLE I—*Continued*

Name	Country	Science	Birth	R	U	G	A	B	F	I	D
Leydig, F. von........	Wurttem-berg	Biology	1821	76	...	*66*	...	80	...	...	87
Lippmann, G..........	France	Physics	1845	67	...	55	...	51	*41*	64	...
Lister, J..............	England	Biology	1827	...	71	...	70	*33*	66	...	86
Lockyer, J. N.........	England	Astronomy	1836	68	...	...	...	*33*	37	47	...
Lorentz, H. A.........	Holland	Physics	1853	57	53	52	58	52	50	49	...
Mascart, E. E. N......	France	Physics	1837	54	...	58	...	55	*47*	62	71
Metchnikoff, E........	Russia	Biology	1845	...	...	...	66	50	67	66	*a*
Michelson, A. A........	U. S.	Physics	1852	...	*36*	...	...	50	48	54	...
Mittag Leffler, G......	Sweden	Mathematics	1846	50	...	...	...	50	54	53	...
Mohn, H.............	Norway	Geography	1835	72	...	65	...	...	...	...	...
Murray, J............	Scotland	Geography	1841	56	71	...	...	*55*	...	71	73*a*
Nansen, F............	Norway	Geography	1861	37	...	...	...	...	34	39	...
Nathorst, G...........	Sweden	Botany	1850	51	...	50	36	...	...	...	...
Neumayer, G. B. von..	Saxony	Geography	1826	...	...	*70*	77	73	...	...	83
Newcomb, S..........	U. S.	Astronomy	1835	61	*34*	48	69	42	39	60	74
Noether, M...........	Bavaria	Mathematics	1844	...	...	*52*	...	...	59	47	...
Ostwald, W...........	Saxony	Chemistry	1853	43	53	*52*	51	...	...	...	...
Pawlow, I. P..........	Russia	Biology	1854	*47*	54	...	...	53	...	53	...
Penck, A.............	Saxony	Geography	1858	...	51	*48*	47	...	...	51	*a*
Pfeffer, W. F. P.......	Saxony	Botany	1845	63	58	*44*	59	52	55	54	...
Pfluger, E. F. W.......	Prussia	Biology	1828	66	...	*72*	...	60	...	71	82
Picard, E.............	France	Mathematics	1856	39	47	42	...	53	*33*	45	...
Pickering, E. C........	U. S.	Astronomy	1846	62	*27*	60	...	61	61	55	...
Poincaré, H...........	France	Mathematics	1854	41	44	42	49	40	*33*	34	58
Ramon y Cajal.......	Spain	Biology	1852	...	...	...	...	57	...	54	*a*
Ramsay, W...........	England	Chemistry	1852	49	52	44	51	*36*	43	55	...
Ranvier, I. A.........	France	Zoology	1835	47	...	...	...	...	*42*	53	...
Rayleigh, J. W........	England	Physics	1842	54	56	54	60	*31*	48	59	...
Retzius, G............	Sweden	Zoology	1842	53	67	51	59	65	53	65	...
Richet, C.............	France	Biology	1850	63	...	...	...	...	...	61	*a*
Righi, A..............	Italy	Physics	1850	46	...	...	...	57	...	*48*	...
Roscoe, H. E..........	England	Chemistry	1833	...	...	...	...	*30*	53	74	...
Rosenbusch, H........	Baden	Geology	1836	...	68	*51*	68	...	63	65	...
Rutherford, E.........	England	Physics	1871	...	40	...	41	*32*	...	...	*a*
Sars, G. O............	Norway	Zoology	1837	59	...	61	...	...	...	...	...
Schiaparelli, E. V......	Italy	Astronomy	1835	39	65	44	39	61	44	*40*	65
Schulze, F. E.........	Prussia	Zoology	1840	55	...	*44*	42	...	...	...	...
Schwarz, H. A.........	Prussia	Mathematics	1843	54	...	*49*	...	...	52	45	...
Schwendener, S........	Prussia	Botany	1829	...	...	*50*	70	84	71	70	...
Seeliger, H...........	Bavaria	Astronomy	1849	64	59	*57*	46	...	...	59	*a*
Strasburger, E.........	Prussia	Botany	1844	66	54	*45*	...	57	56	49	69
Suess, E..............	Austria	Geology	1831	70	67	69	*36*	63	58	52	83
Thomson, J. J.........	England	Physics.....	1856	57	47	54	...	*28*	55	47	...
Thomsen, J...........	Denmark	Chemistry	1826	...	...	74	...	76	...	57	83
Tieghem, P. E. L. v....	France	Botany	1839	69	...	...	51	...	*38*	66	75
Treub, M.............	Java	Botany	1851	...	...	49	...	48	37	...	59
Tschermak, G.........	Austria	Geology	1836	76	...	45	*39*	...	61	47	...
Valdeyer, H. G. G.....	Prussia	Zoology	1836	58	...	*48*	71	...	68	...	...
Voigt, V..............	Prussia	Physics	1850	...	...	*50*	...	63	...	48	*a*
Volterra, V...........	Italy	Mathematics	1860	48	51	...	...	50	44	*39*	*a*
Vries, H. de..........	Holland	Botany	1848	...	56	65	...	57	65	54	...
Waals, J. D. v.........	Holland	Physics	1837	...	76	63	...	...	63	66	...
Walcott, C. D.........	U. S.	Geology	1850	45	*46*	...	...	...	...	51	...
Waldeyer, W..........	Prussia	Zoology	1836	58	...	*48*	71	...	68	...	...
Warming, J. E. B......	Denmark	Botany	1841	...	...	58	...	...	63	65	...
Weismann, A..........	Baden	Zoology	1834	...	79	*63*	77	76	...	...	80*a*
Wiesner, J. v..........	Austria	Botany	1838	74	...	61	*54*	...	71	64	...
Wilson, E. B..........	U. S.	Zoology	1856	...	*43*	57	...	...	...	47	*a*
Zeuthen, H. G.........	Denmark	Mathematics	1839	...	...	...	...	...	61	63	...
Zirkel, F..............	Saxony	Geology	1838	...	65	*49*	45	59	...	61	74

Table II. gives the designation of each society, the country it represents, the year of its foundation, the number of resident members, the number of foreign members and the number of members represented in Table I. The latter sometimes exceeds the present number of foreign associates, owing to deaths and the election of resident members. The care taken by each society in electing members is shown in the last four columns. They give the number first elected by each society, the number first elected of the members of the seven societies, the number last elected of the members of seven societies, and the number not yet elected of the members of six societies. When a member is elected in two societies in the same year, both are included.

TABLE II

SOCIETIES

Des.	Country	Found	Res.	For.	Soc.	F. .	F7	L7	6
R	Russia............	1725	70	97	79	30	5	3	1
U	U. S..............	1863	133	49	64	7	..	6	1
G	Germany..........	1700	37	78	68	15	2	..	5
A	Austria...........	1847	67	45	56	14	2	6	7
B	Great Britain......	1645	472	47	72	14	3	..	..
F	France............	1795	77	125	82	21	3	2	..
I	Italy..............	1603	106	106	94	31	5	1	..

The Lincei is the oldest of the societies, and the Institute of France has the largest number of foreign associates. The Royal Society, the next oldest, has much the largest number of resident members, in fact nearly as many as all the others put together. If any rigid system were adopted for the election of members, each would evidently be elected first into the Institute of France, then into the Lincei, and so on, in the order of numbers. The skill shown by the Russian Academy and the Lincei in selecting members is indicated by the large number of first elections. It was a great triumph for each of them to have elected five men who were not members of either of the other societies, and then to be followed by all of the others. The small number elected by the National Academy is not justified by the number of foreign associates. On the other hand, it is not creditable to a society to have been the last to elect, or to have failed to elect those whose ability had already secured their memberships in the other six societies. Judged by this standard, Austria has overlooked 13 men, the United States 7 and Germany 5. Of the 13, Austria has overlooked 5 astronomers, 3 physicists and 2 mathematicians.

The results of a grouping according to countries are contained in Table III. The name of the country is given in the first column, followed by the number of memberships of 7, 6, 5, 4, 3 and 2, by the total number, the total number of societies, and the number of societies per

member. The last two columns give the number of new members, and the number who have died.

TABLE III

COUNTRIES

Country	7	6	5	4	3	2	All	Soc.	Av.	New	D.
Prussia..........	4	2	3	6	4	3	22	97	4.4	4	6
England..........	3	5	1	3	5	..	17	83	4.9	3	5
France...........	2	2	2	3	8	1	18	74	4.1	7	5
U. S.............	1	2	1	2	4	..	10	44	4.4	4	4
Saxony...........	1	..	1	3	1	1	7	29	4.1	1	2
Italy............	1	1	1	..	3	..	6	27	4.5	2	2
Bavaria..........	1	..	1	1	3	..	6	25	4.2	1	1
Austria..........	1	..	2	..	2	..	5	23	4.6	..	1
Sweden...........	1	1	..	1	1	1	5	22	4.4	1	..
Holland..........	1	..	1	1	1	1	5	21	4.2	2	..
Russia...........	..	..	..	3	1	..	4	15	3.8	1	..
Norway...........	..	1	..	..	1	2	4	13	3.2	..	..
Baden............	..	..	1	1	1	..	3	12	4.0	1	1
Denmark..........	..	..	..	..	2	1	3	8	2.7	..	1
Switzerland......	..	..	..	..	1	1	2	5	2.5	..	1
Belgium..........	..	..	1	..	..	..	1	5	5.0	..	1
Scotland.........	..	..	..	1	..	..	1	4	4.0	1	1
Wurttemberg......	..	..	..	..	1	..	1	3	3.0	..	1
Java.............	..	..	..	..	1	..	1	3	3.0	..	1
Spain............	..	..	..	..	..	1	1	2	2.0	1	..
All..............	16	14	15	25	40	12	122	515	4.2	29	33

It appears from Table III. that the total number of men in Table I. is 122 and that they have a membership of 515, 16 of them are members of all seven societies, and 14 of six. On January 1, 1909, the number of members was 93, on January 1, 1914, it was 89. As in the previous publication, Prussia is ahead of any other country in men, membership and in membership in all seven societies. The average membership is, however, much less than that of England. The progress in France appears from its seven new members, and in the United States by its four new members, equalling in number those of Prussia. Six years ago the United States had no more members than Saxony, although the population was twenty times as great. The total number elected shows an excess of three, although the number living is only one greater, owing to the great loss by death, including the two leaders, Newcomb 7, and Agassiz 6. It is interesting to compare the numbers of Austria and Germany, including Prussia, Saxony, Bavaria, Baden and Württemberg, with England, France, Russia, Belgium and Scotland, and with the nine remaining countries. The number of members in these three groups are 44, 41, 37; of members of all seven societies 7, 5 and 4; of memberships, 188, 181 and 145; of new members, 7, 12 and 10; of deaths, 12, 12 and 9. These numbers are nearly equal, with a slight advantage for Germany.

A grouping according to sciences is contained in Table IV. The

name of the science is followed by the number of members in 7, 6, 5, 4, 3 and 2 societies, the total number of members, the total number of societies, the average number, the number of new members and the number of deceased members.

TABLE IV

SCIENCES

Name	7	6	5	4	3	2	All	Soc.	Av.	New	D.
Mathematics.....	2	2	1	2	6	1	14	59	4.2	3	2
Astronomy......	3	3	2	3	4	1	16	75	4.7	6	6
Geography......	..	1	1	2	4	3	11	37	3.4	5	3
Physics.........	2	2	3	4	4	..	15	69	4.6	3	2
Chemistry.......	4	1	..	1	4	1	11	52	4.7	3	3
Geology.........	2	1	4	3	4	..	13	62	4.7	2	3
Botany.........	1	2	3	..	7	..	13	56	4.3	1	5
Zoology.........	1	1	2	3	6	2	16	60	3.8	2	3
Biology.........	1	..	..	6	2	4	13	45	3.5	4	6
All.............	16	13	16	24	41	12	122	515	4.2	29	33

Chemistry is conspicuous in Table IV. from the large number of members of the seven academies, notwithstanding the small total number of members. Biology and geography may be regarded as somewhat new sciences. At least, comparatively few doctors were members of these societies half a century ago. Accordingly, we find but few having membership in 5, 6 or 7 societies. It is not surprising that the number of zoologists is large, considering the breadth of the subject, and the number included in this profession. On the other hand, the total number of astronomers is small, but the number included here is relatively large. The average membership is also equal to that of chemistry and geology. It is probably due to the interest and rapid growth of astrophysics. In mathematics, the country most largely represented is France with 5 members; in astronomy, United States, 5, England, 4; in physics, England, 5; in biology, Prussia, 5. Great Britain is the only country represented in each of the sciences. Prussia has no geologist on the list, France no geographer, and the United States, no mathematician, chemist, botanist or biologist.

BOTANIZING EXCURSIONS IN BORNEO

BY PROFESSOR D. H. CAMPBELL
STANFORD UNIVERSITY

WITH ships plying to the remotest lands, it is now a comparatively simple matter for the traveler to visit almost any part of the tropics. Indeed, these fascinating regions are now so easily reached that it is becoming difficult to find any country that has not been exploited to such an extent that much of the original vegetation, and with it the rarer animal forms, have been exterminated.

The planter of tea and coffee, of rubber and bananas, sweeps away the jungle in all the more accessible regions, and the traveler often must make long and arduous journeys before he can see the country in its pristine state.

However, there are still many places of comparatively easy access which richly repay the scientific traveler for any slight inconveniences to which he may be subjected.

No part of the world is richer in interesting forms of life, both animal and vegetable, than portions of the East Indies, especially the great Malayan Archipelago. Java with its unrivaled luxuriance of vegetation and magnificent scenery, is now on the regular tourist route, and is familiar to many travelers, scientific and otherwise. The larger sister islands, Borneo and Sumatra, are not so often visited by the tourist, and still contain large tracts of unexplored country. When as a small boy I first read Wallace's wonderful book on the Malay Archipelago, I determined that some day I should see for myself the wonders of these far-off islands in the Eastern Seas. In 1905–06 a sabbatical year gave me my first experience of this beautiful region, and, so satisfactory was that visit, that I looked forward to my next sabbatical leave to renew my acquaintance with the East Indies and to extend my explorations to Sumatra and Borneo which I had not visited on my first trip.

Much the greater part of the huge island of Borneo is still an unknown wilderness whose wild inhabitants render it a perilous region for the explorer. The coastal region is fairly accessible and there is no great difficulty in reaching the main ports. Dutch Borneo, comprising the major part of the island, has been but little exploited when compared with the extraordinary development of Java.

The rest of the island, except the small native state of Bruni, is under British influence, although not strictly British territory. A recent visit to Sarawak proved to be full of novelty and interest, as in some respects the country is unique.

The story of the young Englishman, James Brooke, who became Rajah of Sarawak, reads like the most exciting romance. Under his wise but firm rule, and that of his nephew and successor, the present Rajah, Sir Charles Brooke, who was closely associated with his uncle in the stirring events which accompanied the pacification of the country, a territory as large as England has been redeemed from absolute anarchy and has become a peaceful and prosperous community. Formerly a nest of pirates and head-hunters, where no man's life or property was safe, Sarawak is now a contented and thriving country, where the rights of the humblest native are scrupulously safeguarded.

In this remote island these two Englishmen have ruled as absolute monarchs over a mixed population of Malays, Chinese, Dayaks and various other savage tribes, who all now recognize their indebtedness to the men who have freed them from the intolerable oppression of the native rulers and the constant incursions of the fierce pirates who formerly infested the whole coast of Borneo.

The present Rajah has carried out zealously the policy of his predecessor. This policy has aimed at developing the country primarily for the benefit of the natives, rather than to throw it open to exploitation by foreigners. At the present time the Europeans, mostly English, number but a few hundred in a territory as large as England, and these are nearly all government officials. This country retains its original conditions to a greater degree perhaps than any other Eastern settlement, and the life of the people must be much as it always has been. Although Sarawak has no railways or telegraphs, nor various other "improvements," the traveler will find life not only quite tolerable, but indeed quite delightful and intensely interesting.

Every week an excellent steamer sails from Singapore for Kuching, the capital of Sarawak, and two days on the shallow China Sea brings the traveler to the Sarawak River on which Kuching lies. The scenery along the coast is very fine, bold mountains coming down to the sea and forming magnificent rugged headlands. The mouth of the Sarawak River—or rather the delta—is guarded on either side by a fine mountain some three thousand feet high. Of these two mountains, Mt. Santubong is especially imposing, rising abruptly from the sea, its flanks clothed with primeval forest, the tall trunks sometimes rising a hundred feet without a branch.

Like most tropical tidal streams, the Sarawak River has developed an extensive delta. The low muddy shores are covered with dense mangrove swamps whose exposed mud flats are the haunts of crocodiles and many other less formidable creatures. Among the latter are myriads of curious mud fish which run about in the mud like lizards, or even climb up the roots of the mangroves. These odd creatures with their big heads and goggle eyes are among the queerest of the fish tribe. Bright

blue crabs are also extremely common, and scuttle away to their holes as the boat approaches the shore.

Further up the river and along the narrow channels the bank is often fringed with dense masses of the Nipa palm, whose long, graceful leaves are extensively used throughout the Malayan region for thatch, and also for covering the sides of the native houses. Another palm, the Nibong (*Oncosperma filamentosa*), may often be seen forming groves behind the Nipa zone. This beautiful palm has a tall, slender stem and a crown of extremely graceful feathery leaves.

As the saltness of the water decreases, in ascending the river, the mangroves give way gradually to a variety of other shrubs and trees, supporting many climbing plants and with their branches often loaded with epiphytes. These epiphytic growths, comprising an astonishing variety of ferns and orchids, and other less familiar types, are a marked feature of this intensely humid region.

Back of the belt of shrubs and low trees immediately bordering the river the tall trees of the forest proper now appear, the outposts of the prodigious forests which still cover most of the wet lowlands of Borneo.

Most of the native settlements are along the rivers, which are almost the only avenues of communication except narrow forest trails. These river-people are Malays and the little thatched houses, raised on posts well above the ground, or actually over the water, are much like those one sees everywhere throughout the whole Malayan region. Plying up and down the river may be seen the picturesque native boats, usually having a thatched shelter, which not infrequently serves as a dwelling for these aquatic people. Squatted at the bow, dressed in a gay sarong, and often with a brightly painted sun hat, the owner may be seen propelling his gondola-like craft rapidly and gracefully along the stream.

Kuching, like all of the larger settlements of Malaya, is essentially a Chinese town. Much of the business of the place is in the hands of Chinese, and, except for the government buildings and the dwellings of the Europeans, the architecture is characteristically Chinese. Some of these structures, including several temples, are excellent samples of Chinese architecture, and are very picturesque, the ornamentation often being really admirable in its details. Highly colored glazed pottery in elaborate and often attractive designs is used lavishly in the decoration of the more pretentious Chinese buildings.

The water front is crowded with Chinese and Malay craft, among which the Singapore steamer and the Rajah's yacht seem rather out of place.

Opposite the town, on a sightly hill, lies the Astana, the Rajah's palace, an attractive but quite unpretentious building surrounded by beautiful gardens. Adjoining it is a picturesque but not especially formidable-looking fort. This structure, with the buildings of the

Borneo Company on the opposite bank, contrasts strongly with the typical Chinese architecture of the rest of the city.

The population is about equally made up of Chinese and Malays, the latter occupying a special quarter on the outskirts of the town. A small number of Tamils from southern India and an occasional Sikh from the northern Indian provinces add variety to a decidedly variegated population. The Chinese women often adopt the gay Malay dress and may easily be mistaken for Malays. The latter are fond of bright colors, and a bevy of native women in their gay sarongs and delicately tinted jackets would be hard to beat as a color study. In Sarawak especially they also affect veils of various bright tints which they drape about their head and shoulders with all the grace of a Spanish woman's mantilla. Indeed, the artist in search of novel and striking color studies could not do better than to pitch his easel in Kuching.

The steamy hothouse atmosphere of Sarawak is of the true equatorial type. Kuching, lying within a degree of the equator, has a uniformly hot and humid climate, under whose forcing influence the vegetation attains a luxuriance which few places, even in equatorial lands, can equal. All the commoner forms of tropical vegetation abound. Palms, bamboos, bananas, orchids and the other plants familiar to those who know the tropics grow everywhere, and the gardens in Kuching exhibit a wonderful profusion of rare and beautiful trees and shrubs. Moreover, the stems of the palms and the trunks and branches of the other trees are laden with ferns, orchids and other epiphytes in bewildering profusion, while creepers with brilliant flowers of every hue are draped over the fences and clamber up the trees.

In the immediate vicinity of Kuching the original forest has mostly disappeared; but in many places the second growth of trees is of good size, and there is a dense undergrowth composed of a great variety of shrubs and herbaceous plants.

One does not have to go far, however, to see samples of the primitive forest, which is very difficult to explore, as the ground is usually a swamp, or else is covered with an impenetrable thicket.

Ferns are abundant, both epiphytic and terrestrial species. Among the most characteristic are species of Gleichenia forming dense thickets, and some very beautiful climbing ferns of the genus *Lygodium*.

Pitcher plants (*Nepenthes*) are extremely common, as they seem to be everywhere in Borneo.

Among the showy flowers noted about Kuching were various Acanthaceæ and Melastomaceæ, and perhaps the most striking plant is *Wormia pulchella,* a shrub belonging to the Dilleniaceæ. It is a common plant of the Malayan region, and its big golden yellow flowers and handsome foliage make it extremely ornamental. Sometimes a bright scarlet *Æschynanthus* was seen, climbing up the trunk of a tree, but this was not very common.

A number of interesting liverworts were collected at Kuching, but, as is usual in the tropics, these are more abundant at higher elevations.

Every season in Sarawak is a "rainy season," but the official rainy season includes the months of November to March, and I can testify from experience that this *is* a rainy season. During the months of December, January and February (1912–13), over one hundred inches of rain fell in Kuching.

As might be expected, this great rainfall contributes to an extremely rich and varied native flora, and Sarawak offers an especially inviting field to the botanist.

Not the least serious problem that confronts the traveler is that of transportation. Except in the town and in the immediate vicinity of Kuching, almost the only means of transport are the streams or else forest trails which are not feasible for either saddle or pack animals, and especially in the low lands are often largely under water. This makes expeditions into the magnificent forests anything but a pastime, and involves not only great fatigue, but also incidentally the discomforts of swarms of mosquitoes and leeches, the latter being especially numerous and voracious in the Bornean forests.

The various native tribes, Land and Sea Dayaks, etc., are of great interest to the ethnologist, but as my interests were chiefly botanical, and my time very limited, I was obliged to leave Sarawak with only the most cursory observation of these interesting savages.

One of my principal objects in visiting Sarawak was to secure specimens of two rare ferns, *Matonia sarmentosa* and *Macroglossum alidæ,* as yet known only from this country, and the first collecting trip undertaken was in search of these.

Through the kindness of Mr. J. C. Moulton, director of the Sarawak Museum, who accompanied me on this trip, I succeeded in accomplishing my object in a highly satisfactory manner.

We left Kuching before daylight in one of the launches of the Borneo Company, and watched the dawn come up behind the dense jungle reflected in the glassy surface of the broad river. In the delicious coolness of the early morning our launch plowed its way up stream, breaking the mirror-like surface of the river, in which were reflected the brilliant tints of the eastern sky. A dense wall of verdure, spangled here and there with white, yellow and purple flowers, bounded the stream on either side.

By eight o'clock we reached our landing place, and after a good breakfast, proceeded by "trolley" for about half an hour to the government bungalow, where we had arranged to camp for a few days while making our collecting trips.

The Bornean trolley is rather a different affair from what one associates with the word in America. The track is an extremely narrow

gauge affair, and the cars are tiny things, consisting of a platform about three feet by four. These are propelled by a man standing on the platform and pushing the car along with a pole. At Bau, in the neighborhood of our bungalow, there are the most important gold mines in Sarawak, and these trolleys are used for transporting ore and other freight. The "passenger coach" has a single seat with a foot-rest. These cars are extremely cranky, and upsets are usually part of the regular program. On an expedition from Bau, my trolley was a two-man power affair, my propellers being a Sikh policeman and a convict in his charge. We were going along famously, when, at a sudden turn the car jumped the track, and the tiffin basket which was resting between my legs jumped also! There was an ominous sound of breaking glass and a strong alcoholic aroma pervaded the atmosphere. Alas! the bottle of Scotch our kind host had thoughtfully provided for our refreshment was shattered to fragments—the soda-water bottles survived.

No further accidents occurred, and we soon reached the end of the line and set off for the jungle-clad base of the limestone crags which were our objective point. After pushing through a dense growth of coarse grass and wading a couple of shallow streams we reached the base of the cliffs, and, after eating tiffin, proceeded to explore the caves with which the rocks are honeycombed. In one of these caves, whose opening lay a hundred feet or so above the foot of the cliff, and which could be reached only by scaling a crazy, more than half-rotten native ladder, the fern we were in search of was seen hanging from the roof of the cave, fifty feet or more above its floor, and quite out of reach. However, after we left, our host arranged with some of the Dayaks, who are accustomed to climb the walls of these caves in search of the edible bird's nests which abound in them, to return with ladders and poke down the clusters of ferns, which were afterwards sent us in Kuching.

These caves are of all shapes and sizes, and are the haunts of the peculiar swift, whose nests, composed of a mucilaginous secretion, are considered such a delicacy by the Chinese.

Matonia sarmentosa is known only from a few limestone caves in Sarawak. A second species, *M. pectinata,* was for a long time supposed to be confined to Mt. Ophir in Malacca. It has now been collected at several stations in the Malay Peninsula, and the adjacent islands. I collected it on Mt. Santubong, and it is also reported from Mt. Mattang, both mountains of Sarawak.

The next morning a second trolley trip took me to the locality where the second fern, *Macroglossum Alidæ,* for which I had come to Sarawak, had been discovered by my host, who was able to give me exact directions for finding it; and I shall not soon forget my sensations when, just where we had been told, we found our plant—a magnificent fern with stately erect fronds more than four yards long. A happy morning

was spent collecting a fine series of specimens for future study, and well content I returned to Bau for tiffin.

Before returning to Kuching a day was spent exploring Mt. Sarambo, a place of special interest to the naturalist, because it was one of the places where Wallace made some of his most important collections in Borneo more than fifty years ago. My companion, Mr. Moulton, showed me the site of Wallace's house, where he had himself camped a couple of years before.

On Sarambo there are a couple of small communities of Land Dayaks who received us very hospitably, regaling us with green cocoanuts whose water was most refreshing after our hot climb.

My most interesting experience in Borneo was a week spent on Mt. Mattang, about ten miles from Kuching, but more conveniently reached by a rather roundabout route by water. This mountain was *tabu* for some reason, and consequently was avoided by the Land Dayaks, who, from time to time, have cleared most of the lower hill slopes in the neighborhood. Except for some relatively small clearings, planted to tea and coffee by the Rajah, the mountain is still covered by magnificent virgin forest. The Rajah built a small bungalow about forty years ago in this clearing, an unpretending, but sufficiently comfortable building, which was kindly placed at my disposal during my stay on the mountain. The site was formerly occupied by a temporary structure erected by the well-known Italian botanist, Beccari, who in the sixties spent a long time in Sarawak and made extensive collections on Mattang. These included many new species. Beccari called his dwelling Valombroso, and this name was transferred by the Rajah to his bungalow.

Accompanied by my Chinese boy and half a dozen coolies carrying the necessary impedimenta for a week's camp (including a crate of chickens and one of the huge pineapples for which Sarawak is famous) I was soon comfortably established, and, for the time being, monarch of all I surveyed.

The surrounding forest is an intensely interesting one. Gigantic trees bound together by great lianas, like huge cables, and with their trunks and branches often quite covered with a profusion of epiphytes, rose from a dense undergrowth of palms, giant ferns, rattans and a host of other strange tropical growths.

The wet banks were covered with beautiful ferns, liverworts and mosses and, although, as is usually the case in the tropical jungle, flowers were not conspicuous, there were a number of very beautiful ones. One of the prettiest (*Didymocarpus*) had small fox-glove-shaped pale purple flowers borne on slender stems rising from a rosette of very dark green, almost black leaves, exquisitely veined with snowy white. These dainty plants grew abundantly on the mossy banks, mingled

with delicate ferns, and made a picture of exquisite beauty. Several showy orchids were occasionally met with, and a straw-colored rhododendron (*R. Salicifolium*) was found in considerable numbers in one locality. A common and showy shrub of the upper forest was a species of *Ixora,* whose clusters of scarlet flowers were not unlike some of the *Bouvardias* which are sometimes grown in our greenhouses.

Ferns in great variety, ranging from tiny filmy ferns, looking like delicate mosses, to magnificent tree ferns, thirty or forty feet in height, abounded everywhere and furnished some interesting specimens.

As usual in the mountain forests of the tropics, epiphytic ferns are abundant, as well as striking species of epiphytic Lycopodiaceae. Besides the genus Lycopodium, represented by several species, the curious *Psilotum flaccidum* was occasionally seen. This plant, whose affinities are not quite clear, grows on the trunks of tree-ferns.

As evening fell the air fairly vibrated with the noise of innumerable insects—cicadas, grasshoppers and crickets, to which were added the pipings of tree toads and the bass booming of bull frogs. One felt curiously remote from all civilization, realizing that the nearest white man was miles away.

The weather was decidedly uncertain with a good deal of rain, and due no doubt largely to the moisture, the wet banks, the decaying logs and dead leaves and twigs on the ground, gleamed at night with an uncanny radiance. A little gully back of the bungalow glowed with this weird luminosity and would have made a fitting setting for some incantation scene. This phosphorescence, while not unknown in temperate regions, is very much more marked in the steaming tropical jungle.

A few days also were spent at the base of Santubong, the mountain lying on the opposite side of the delta of the Sarawak from Mattang, from which it differs much, in both its form and vegetation.

This striking mountain rises abruptly from the water, and although of no great height—barely three thousand feet—its steepness and fine contour make it a most imposing object.

A typical Malay fishing village lies at its base on the river side. On the seaward side is a broad beach interrupted at intervals by shelving ledges of rock and with here and there small patches of mangroves. Along the upper boundary of the beach is a belt of vegetation made up for the most part of a number of trees and shrubs characteristic of the Malayan "Strand forest."

The largest trees of this belt are *Casuarinas,* looking like straggling pines, and next in size is a species of *Terminalia,* a tree with the branches arranged in regular tiers and covered with big glossy leaves. Somewhat similar in appearance, but not closely related botanically, is *Barringtonia,* with big white flowers not unlike those of *Eucalyptus,* but very much larger, and beautiful dark green shining leaves. A yellow

Hibiscus, very much like the hau tree (*Hibiscus tiliaceus*) of Hawaii (perhaps identical), was also abundant. A most characteristic small tree or shrub was a screw pine (*Pandanus*), with long slender leaves arranged in a dense spiral, and big heads of fruit, the color and size of ripe pineapples. Of the flowering shrubs, much the showiest was a species of *Wormia* with big golden yellow flowers and handsome foliage. There were also several leguminous shrubs with yellow and purple flowers. A considerable number of climbing plants occur, among them several species of *Ipomœa* very much like our common morning glories. A species of *Gnetum,* with clusters of showy salmon-pink berries, was also common along the shore.

The ascent of the mountain is decidedly arduous, as the trail is very steep, and at times it is necessary to scale the face of almost sheer rock ledges, where one must pull one's self up by the roots of trees or by clinging to such shrubs and roots as could find lodgment in the rock crevices.

The forest is comparatively open, and did not offer much collecting until the summit was reached. Here the forest is composed of gnarled and dwarfed trees whose trunks and branches are moss-covered and serve as a foothold for a host of beautiful epiphytes. The latter included two superb rhododendrons with snowy white and brilliant flame colored flowers; a number of interesting orchids and several pitcher plants (*Nepenthes*), one of which *N. veitchii,* is one of the finest of the genus, with pitchers a foot or so in length.

The ground was covered with a dense cushion of moss, in some places sphagnum much like that found in our northern bogs, and seeming rather out of place in the tropics.

The great forests of Borneo are hardly equalled in the variety and size of the trees of which they are composed. As in other parts of the Malayan region, the most important timber trees belong mainly to a family, Dipterocarpaceæ, which is quite unrepresented in the New World. The Dipterocarps are often trees of great size, with straight trunks which may rise a hundred feet or more without a branch, and yielding timber of great value. There are also many leguminous trees, remotely related to our own locusts and honey-locust. One of these, the tapang (*Abauria excelsa*), is the tallest tree yet measured in the Malayan region. Beccari mentions one of these two hundred and thirty feet in height.

Many other trees, unfamiliar to the American botanist, are components of the Bornean forest. Wild figs and banyans are conspicuous, and several species of *Artocarpus,* related to the cultivated bread-fruit, and also wild species of durian and mangosteen, the two choicest fruits of the eastern tropics.

A few types, however, appear less strange. Oaks of several species

occur, even at sea-level, and in the higher mountains are a number of coniferous trees, mostly, however, of genera which do not occur in America.

The most characteristic genera of conifers in the Malayan region are *Agathis,* to which belongs also the Kauri pine of New Zealand, and *Podocarpus,* also well represented in the latter country. Another Malayan coniferous type is *Dacrydium,* which also extends to the Australasian region.

Borneo, probably, has more species of palms than any other area of like extent in the world; but these are often small and quite inconspicuous forms nor else they are climbing species, rattans, which are quite different in appearance from the typical palms. There are, it is true, a good many large and striking palms, but as a rule they do not dominate the vegetation to the same extent as in equatorial America.

The screw pines, or pandans, have already been referred to, and these very peculiar plants are a most striking feature of the eastern tropics and one quite absent from the New World. They may attain the dimensions of trees, and there are numerous species occurring from sea level to a height of four thousand to five thousand feet. The strange pitcher plants of the genus *Nepenthes* constitute another peculiarly Old World type, and these attain the greatest development in Borneo where they are very common and occur at all elevations up to eight thousand feet or more. These interesting plants, which one may occasionally see in hothouses, differ a good deal in the structure of their pitchers from our American pitcher-plants; but, like the latter, these pitchers are insect traps. The pitchers in *Nepenthes* are borne on tendrils at the tip of the leaf, and are often of very graceful form and beautifully colored.

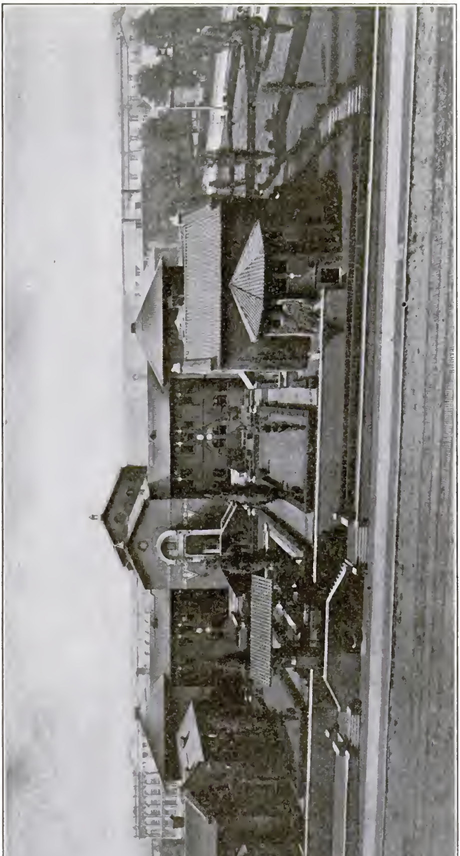
As in all wet tropical countries, Borneo has a great many species of Araceæ, some with gigantic leaves five or six feet long, looking like huge callas. Others, *e. g.*, species of *Amorphophallus,* have enormous leaves much divided and produce immense flowers with a most evil scent. Others, again, are climbers and clothe the trunks of trees in a luxuriant drapery of bright glossy leaves.

One naturally looks for many orchids in such a country as Borneo, and in fact the number of species is very large; but, as every collector knows who has visited the tropics, it is only rarely that showy orchids are abundant enough to make a striking display. The great majority of orchids are small plants with insignificant flowers which would be quite overlooked by any one but the botanist. There are, it is true, a great many orchids of extraordinary beauty in Borneo, but these are for the most part rare and are only occasionally met with in flower. Two handsome orchids are common in the gardens about Kuching, *Vanda teres* and *Arundina speciosa,* both of which flower freely. Another

pretty orchid, which at intervals blooms in great profusion, is extremely common, growing on trees. This is known locally as the dove orchid (*Dendrobium crumenatum*). It has the peculiar habit of flowering all at once over a large area, and for a single day the long sprays of beautiful white sweet-scented flowers may be seen by the thousands. The next day they are all withered and not a single fresh flower can be found.

As might be expected, the constant moisture favors a luxuriant growth of ferns, mosses, fungi and lichens, which show a bewildering variety of forms, and a marvellous luxuriance. These lower plants, except the ferns, have received comparatively little attention, and a magnificent field is waiting for the botanist interested in these.

It was with deep regret that I said good-bye to this fascinating country, and to the kind friends who did so much to make my brief stay a pleasant and profitable one. Some day, perhaps, I may be fortunate enough to return and explore further the botanical treasures of this wonderful land.



THE MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA.

THE PROGRESS OF SCIENCE

THE CONVOCATION WEEK MEETINGS

THE American Association for the Advancement of Science together with a large number of national scientific societies affiliated with it held at Philadelphia, as had been anticipated, a meeting of more than usual magnitude and interest. The University of Pennslvania is always a generous host, and not only placed at the disposal of the visiting scientific men its laboratories and lecture halls, but was able to provide in Houston Hall an admirable headquarters for registration, council meetings and informal gatherings, while the luncheon served daily in the gymnasium and the evening reception given by Provost and Mrs. Smith in the Museum, offered further opportunities to meet old acquaintances and to form new ones.

Dr. Charles W. Eliot, president emeritus of Harvard University, gives distinction to any meeting over which he presides, and the address of the retiring president, Dr. Edmund B. Wilson, professor of zoology in Columbia University, supported the thesis that scientific eminence is likely to be associated with literary and artistic skill. The program of the meeting, consisting mainly of titles of addresses and papers, filled a volume not much smaller in size than a number of THE POPULAR SCIENCE MONTHLY, and it is obviously impossible to refer even by title to such a series of papers, summing up a great part of the scientific work accomplished in this country during the past year. As there were some two thousand scientific men in attendance and a considerable number of visitors from the city, good audiences were provided even when twenty or thirty meetings were being held simultaneously.

A new feature of the meeting was a session of the Committee of One Hundred on Scientific Research appointed a year ago. Professor E. C. Pickering presided, and reports were presented by subcommittees on research funds, the attitude of colleges and universities to research, the better recognition and greater encouragement of research, the selection and training of men for research, and the research work of industrial laboratories. Committees were appointed on research work under the government, research work on the Pacific coast and the use of the research funds of the association, which latter committee is timely, in view of the fact that Mr. Colburn, one of the fellows of the association, last year made to it a bequest which may amount to over one hundred thousand dollars.

The association will meet next summer in San Francisco and the neighboring universities and next winter at Columbus. Dr. W. W. Campbell, director of the Lick Observatory, was elected president, and most of the vice-presidents were elected from among the scientific men residing on the Pacific coast, their names and work indicating how actively that region is engaged in important scientific research.

The societies devoted to physiology, anatomy and biological chemistry met this year at St. Louis, the geographers, historians and philosophers at Chicago, and the economists and sociologists at Princeton. It is planned to have once in four years a special convocational week meeting in which all scientific men and scientific societies will be invited to join, the first to be in New York two years hence.

After the close of the other meetings, there was held in New York City on January 1 and 2 a gathering of university professors,' who organized a new society to be known as the American Association of University Professors, intended to accomplish for teachers in our higher institutions of learning the objects attained in kindred professions by the American Med-

ical Association and the American Bar Association. Professor John Dewey, of Columbia University, who had been chairman of the committee on organization, presided at the meeting and after the association had been formed was elected its first president. Professor Arthur O Lovejoy, of the Johns Hopkins University, who had been secretary of the committee on organization, presented plans which had been drawn up by the committee. An opening address by the chairman outlined the needs and purposes of such an organization, and this was followed by a number of general addresses, after which most of the time during the three sessions was devoted to discussion of the plans and objects of the association, as embodied in the constitution, which was ultimately adopted in a provisional form.

THE PRODUCTION OF IRON ORE IN 1914

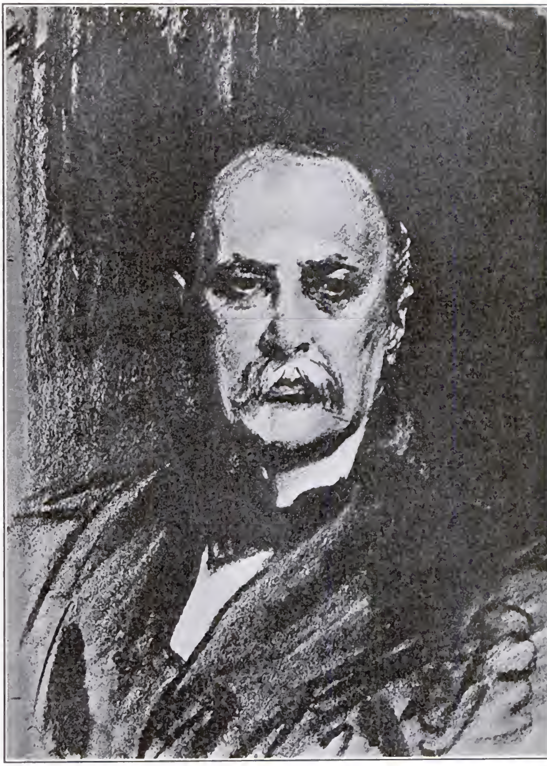
THE mining of iron ore and the manufacture of iron are regarded as a valuable index of commercial prosperity and interest attaches to the report of Mr. Ernest F. Burchard, of the U. S. Geological Survey, according to which the quantity of iron ore mined in the United States in 1914 is estimated to have been between 41,000,000 and 42,500,000 long tons, and the quantity shipped from the mines to receiving ports and iron-manufacturing centers between 39,500,000 and 41,000,000 long tons. These estimates are based on preliminary reports from 52 of the important iron-mining companies which represent the principal iron-producing districts and whose combined output in 1913 was more than 90 per cent. of the total tonnage of iron ore mined in that year.

The average decrease in quantity mined by these 52 companies was 33 per cent. compared with their output in 1913, and if this average decrease should hold for all the iron-mining companies in the United States the total output of iron ore in 1914 should approximate 41,440,000 long tons, compared with 61,980,437 long tons mined in 1913. A curve of iron-ore production would therefore show the output of 1914 to be about on a par with that of the years 1905 and 1911. Coincident with the decrease of 33 per cent. in ore mined the iron ore shipped from the mines by the same producers decreased also 33 per cent., and if the shipments for the whole country are figured on this basis the quantiy of ore shipped should approximate 39,810,000 long tons, compared with 59,643,098 long tons shipped in 1913.

In the Lake Superior district, where about 85 per cent. of the domestic iron ore is mined, the average decrease in production was about 37 per cent., thus indicating a total production for that district of about 32,915,000 long tons in 1914, compared with 52,518,158 long tons mined in 1913. The shipments of ore from this district apparently decreased about 34 per cent., and accordingly the shipments should approximate 32,790,000 long tons in 1914, compared with 50,168,134 long tons in 1913.

According to the preliminary reports the stocks of iron ore at the mines apparently increased more than 500,000 long tons during 1914, so that the total stocks at the close of 1914 should range between 13,400,000 and 13,500,000 long tons, compared with 12,918,633 long tons on hand at the close of 1913. These figures are, however, subject to greater uncertainty than the other estimates, because the returns to the survey are based largely on estimated data.

Officials of the iron-mining companies are almost unanimous in reporting great depression of trade during 1914. Prices generally were 50 to 75 cents a ton lower than in 1913—as low as or lower than those of 1912 and 1905. The depression in the iron industry affected seriously the lake carrying trade, which depends largely on the transportation of ore from the Lake Superior district to ports at the head of Lake Michigan and at the foot of Lake Erie. During the later part of the autumn probably as many iron mines



SIR WILLIAM OSLER.

were closed or running on half time as at any other time for many years, and owing to the present inactivity in the industries which consume iron ores and to the accumulation of considerable ore stocks in the hands of the consumers, the iron-mining companies are not expecting great activity in the early part of 1915.

SIR WILLIAM OSLER

ON the occasion of the celebration of the twenty-fifth anniversary of the Johns Hopkins Hospital last October a crayon portrait of Sir William Osler by Mr. Sargent, here reproduced, was presented to the hospital through Professor William S. Thayer, who spoke as follows:

The precious gift it is my privilege now to offer to the hospital is but another reminder of him who, though absent in person, has been with us and in us and around us in spirit from the beginning of this gathering. What have been his contributions to medical science, what his inspiration and efforts and example have been to this institution, are so familiar to us all that it would be impudent to mention them. Would that we could put into words the influence that the man has had upon our lives! How much of that which is best in us is due to him and to his example! In all the fifteen years of my close and constant association with him I never knew him to do a hasty or an inconsiderate act, and I never heard him speak an unkind word of any man. Of how many can one say this? He is like Maeterlinck's true sage, in whose presence discord and strife and misunderstanding are impossible. In losing him we felt that we had lost our best friend and adviser, but he left us a legacy of tolerance and forbearance and charity that is among the richest of our possessions. This whole institution is replete with memories of the man; and no statue, no tablet, no portrait can bring him more vividly to our minds. But there will be others who follow after to whom our poor words will convey but a faint picture of that which is a part of us. And so his old disciples welcome with heartfelt gratitude every new image which may help better to fix for posterity the presence of our dear chief. The value of this new possession is greatly enhanced in that it comes to us through the thoughtful generosity of her who shares with him our lasting love and affection. Lady Osler, of her own initiative, has induced Mr. Sargent to make this replica of the portrait drawn by him for the College of Physicians in Philadelphia, and has sent it to us to-day. And so after all he is with us! We shall gain new inspiration from his counterfeit presence. Let us wait patiently in the hope that, four years hence, when the heavy clouds of the hour shall have rolled away, we may give him that welcome which our hearts hold for him to-day.

SCIENTIFIC ITEMS

We record with regret the deaths of Samuel Benedict Christy, professor of mining and metallurgy in the University of California; of Charles Martin Hall, the American electrochemist; of Professor N. C. Dunér, the Swedish astronomer; of Dr. Charles Périer, one of the most distinguished surgeons in France, and Dr. A. Van Geuchten, professor of anatomy and neuro-pathology at Louvain University.

Signor Guglielmo Marconi has been appointed a member of the Italian senate by King Victor Emmanuel.—It is one of the privileges of the Spanish Academia de Medicina that it is entitled to a seat in the senate. The member of the academy recently elected senator in this way is Dr. B. G. Alvarez, one of the editors of the *Pediatria Español*.—The gold medal of the Geographical Society of Chicago has been awarded to Colonel George W. Goethals. It will be presented to him at a dinner to be given by the society on January 23.

Several large bequests are reported this month for educational and public purposes. Dr. Charles M. Hall, known for his work on aluminum, bequeaths $3,000,000 to Oberlin College; Miss Grace Dodge, who during her lifetime was active in educational and charitable work, leaves $500,000 to Teachers College, Columbia University, $700,000 to Young Women's Christian Associations and other public bequests. Large bequests for public purposes are made by the will of Mrs. Mary Anna Palmer Draper, to whom in her lifetime science was greatly indebted for intelligent and generous support, including $150,000 to the Harvard College Observatory and $450,000 to the New York Public Library.